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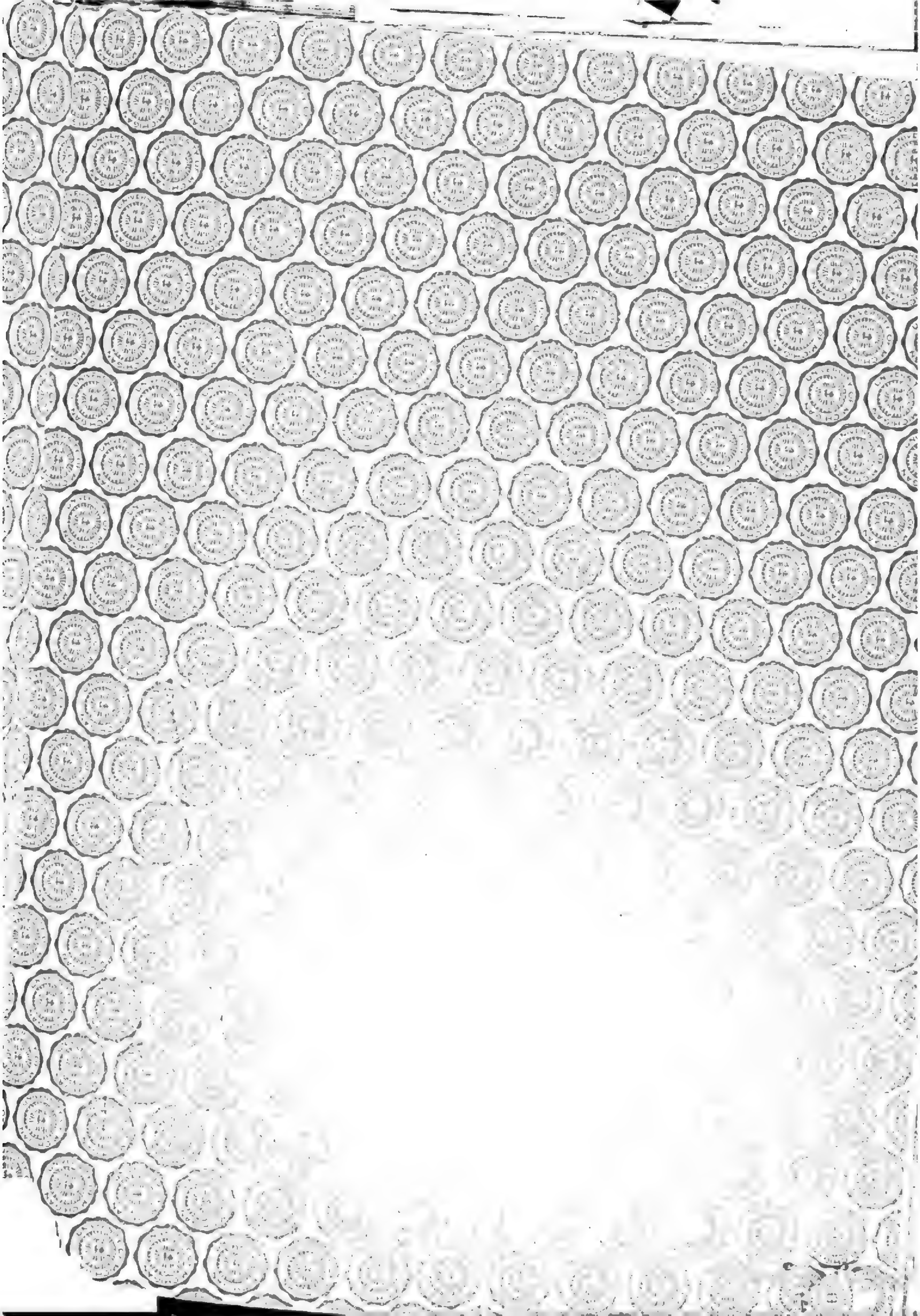

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HIMALAYAN FOSSILS.

Vol. II, Part 1.

THE CEPHALOPODA OF THE LOWER TRIAS.

HIMÁLAYAN FOSSILS.

VOLUME II., PART I.

THE CEPHALOPODA OF THE LOWER TRIAS.

BY

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WITH PLATES I TO XXIII.

INTRODUCTION.

The first Himálayan ammonite of lower triassic age which is mentioned in scientific literature, is *Ophiceras demissum*, described and figured by A. Oppel in 1865, although its geological position was not known to this eminent author.[1]

Whether *Ammonites peregrinus*, which was collected in Ladakh by the missionary Prochnow and described by E. Beyrich,[2] actually belongs to deposits of lower triassic, Muschelkalk, or even of permian age, cannot be decided. The fragment which constitutes Beyrich's type specimen, is the only one of this species found up to now. E. v. Mojsisovics, it is true, discovered similar forms in a red marble from Woábjilga on the Karakorum route, which are probably of permian age, but they were too badly preserved to allow identification with Beyrich's species.[3]

In 1865 C. W. Gümbel recognised some genuine lower triassic fossils amongst the collections which were brought to Europe by the brothers Von Schlagintweit.[4] He even identified a few bivalves from the sandstones of Balamsáli in Spiti with typical species from the Alpine Werfen beds, as *Anoplophora fassaënsis*, Wissm., *Lima costata*, Münst., *Nucula Goldfussi*, v. Alb., and he considered the beds, in which these fossils were found, as equivalents of the lower triassic Buntsandstein.

To C. L. Griesbach, however, we owe the actual discovery of a Himálayan lower triassic rock series *in situ*. In the *Otoceras beds* near the Niti Pass he discovered, in 1879, the oldest cephalopod fauna of the Buntsandstein, and fixed its stra-

[1] *A. Oppel.*—Ueber ostindische Fossilreste aus den secundären Ablagerungen von Spiti und Gnari-Khorsum in Tibet. Palæontologische Mittheilungen aus dem Museum des Königl. bayrischen Staates, Stuttgart, 1, 1865, Pl. 80, fig. 1 a, b, c, p. 290.

[2] *E. Beyrich.*—Monatsber. Königl. preuss. Akad. der Wiss. Berlin, 18 Januar 1864, p. 58.

[3] *E. v. Mojsisovics* in *E. Suess*,—Beiträge zur Stratigraphie Central-Asiens. Denkschr. kais. Akad. d. Wiss. Wien, math.-nat. Classe. 1894, p. 458.

[4] *C. W. Gümbel.*—Über das Vorkommen von unteren Triasschichten in Hochasien (Nach den von den Gebrüdern Schlagintweit gesammelten Fundstücken beurtheilt). Sitzgsber. Königl. bayr. Akad. Wiss. i. München, 1865, pt. 5, pp. 348—366.

tigraphical position just above the upper boundary of the permian Productus shales, and below a mass of shales alternating with limestones and overlaid by true Muschelkalk.[1] He also rightly claims having discovered a second cephalopod bearing horizon in Spiti, situated somewhat higher than the Otoceras beds of Spiti and Painkhánda, and identical with the upper beds of the lower triassic series, for which I have proposed the name "*subrobustus beds*" in my Memoir on the Cephalopoda of the Himálaya Muschelkalk.

He thoroughly recognized the difference between the two faunæ, as may be clearly seen from his scheme of the divisions of the Himálayan trias (Mem., Vol. XXIII, p. 70), but he did not separate the two lower triassic horizons in his detailed sections. In doing so he was, however, fully justified, as he had not sufficient proofs to compare the fauna of Muth in Spiti with that of the subrobustus horizon, in his normal section of the Shalshal cliff near Rimkin Paíar encamping ground.

In 1892 our expedition was fortunate enough to discover some very characteristic species of ammonites in the upper portion of the lower triassic deposits of the Shalshal cliff. This section, which is exposed just opposite the camping ground of Rimkin Paiar, a little below the confluence of the Barahoti and Chorhoti rivers, is as shown in the figure on the opposite page.

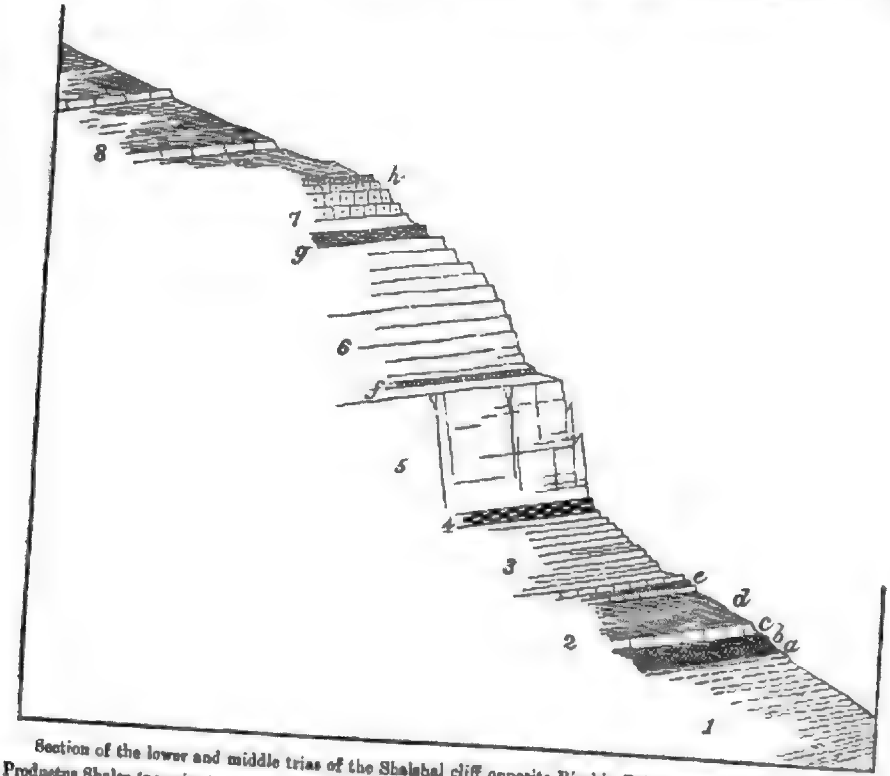
The palæozoic group of rocks terminates with the permian Productus shales, which are exposed to a height of about 90 feet above the ravine of the Shalshal river. As to their lithological character I need not add anything to Griesbach's excellent descriptions. Their uppermost beds, the only ones which we examined in this section, yielded no fossils whatever, but contained many concretions, similar to those of the well known Spiti shales.

The higher Otoceras beds of the lower trias begin with a series of limestones and shales, which pass almost gradually into the underlying Productus shales. The limestones are grey or black, weathering a rusty brown colour, and form very regular banks of 4 to 6 inches in thickness. The shaly layers, with which they alternate, are of equal thickness, and of a less decided colour than the ferruginous, dark, shining Productus shales and do not contain any concretions. There is, however, no distinct boundary to be drawn between the two rock facies, which form one continuous sequence of beds, as has already been pointed out by Griesbach.

The lowest banks of limestones and shales, immediately above the Productus shales, yielded no fossils. In our section, all the enormous number of fossils, the discovery of which we owe to Griesbach, is concentrated in one bed, situated from 18 to 30 inches above the upper boundary of the Productus shales, which consists of a dark bluish or black limestone of 6 to 12 inches in thickness. This limestone bank is as a rule a true lumachella like layer of cephalopoda, most of which are splendidly preserved. Broken shells are proportionately rare. In consequence of the tough nature of the matrix, the extraction of complete specimens is, however, difficult. Among the cephalopoda different species of the genus *Ophiceras*, Griesb. pre-

[1] *C. L. Griesbach*,—Records, Geol. Survey of India, XIII, 1880, pp. 83—113, XIV, 1881, pp. 154, 166. Geology of the Central Himálayas, Mem. Geol. Surv. of India, XXIII, 1891, especially pp. 67—71, 121, 147, 219—223.

dominate. Besides them *Otoceras*, Griesb., forms the principal fossil of this horizon.



Section of the lower and middle trias of the Shalshal cliff opposite Rimkin Paiar encamping ground.—

1. Productus Shales (permian).
2. Otoceras beds:
   - a Main layer of *Otoceras Woodwardi.*
   - b Shales with *Medlicottia Dalailamæ.*
   - c Limestones with *Ophiceras*, sp.
   - d Shales.
   - e Shales alternating with limestones.
3. Subrobustus beds.
4. Horizon of *Sibirites Prahlada.*
5. 6. Muschelkalk {Lower / Upper} Division.
   - f Main layer of *Ceratites Thuilleri.*
   - g „ „ „ *Ptychites rugifer.*
7. Crinoid-limestones with fossils of the Aonoides-Horizon (*Joannites* cf. *cymbiformis.*)
   - h Halobia bed of the Aonoides horizon.
8. Daonella beds.

The fauna of this bed, from which about 50 per cent. of all the fossils of the Otoceras beds have been collected, contains the following species :—

Nautilus brahmanicus, Griesbach.
Danubites, sp. ind.
Otoceras Woodwardi, Griesb.
„ *fissisellatum*, nov. sp.
„ *Clivei*, nov. sp.
„ *Draupadi*, nov. sp.
Hungarites, sp. ind.
Medlicottia Dalailamæ, nov. sp.
Vishnuites, nov. gen. *Pralambha*, nov. sp.
Ophiceras tibeticum, Griesb.

Ophiceras Sakuntala, nov. sp.
" *demissum*, Oppel.
" *gibbosum*, Griesb.
" *platyspira*, nov. sp.
" *ptychodes*, nov. sp.
" *serpentinum*, nov. sp.
" *Chamunda*, nov. sp.
Meekoceras boreale, nov. sp.
" *Hodgsoni*, nov. sp.
Kingites Varbha, nov. sp.
Koninckites Vidarbha, nov. sp.

In comparison with the enormous number of cephalopoda, the other groups of the mollusca remain considerably in the back ground. Lamellibranchiata are, however, widely spread throughout this bed, whereas gasteropods and brachiopods are extremely rare.

This bed, forming the main layer of *Otoceras Woodwardi*, Griesb., and its allies, is immediately overlaid by greenish, splintery shales of 6 to 8 inches in thickness, containing fragments of *Otoceras*, and besides them the following forms:—

Medlicottia Dalailamae, nov. sp.
Proptychites Scheibleri, nov. sp.
Prosphingites Kama, nov. sp.

For 3 feet above the main layer of *Otoceras Woodwardi*, these thin bedded, splintery shales are succeeded by limestones, which yielded only a few fragments of *Ophiceras*, too badly preserved for any specific determination. Above these limestones occur splintery, thin bedded shales with limestone partings, and without any trace of fossils, of 7½ to 9 feet in thickness. Higher up, the shale formation passes gradually into a series of limestones alternating with shales. The lowest beds, up to a height of 18 feet above the main layer of *Otoceras woodwardi*, have yielded *Ophiceras Dharma* and *Danubites sp. ind. ex aff. D. planidorsato*, besides many fragments of ammonites, which did not permit specific determinations but most probably belong to the genera *Ophiceras* and *Meekoceras*.

In the upper beds, of about 30 feet in thickness, the limestones become gradually less dark, and often show yellow coloured patches on their weathered surfaces. Their lithological character gradually approaches that of the Muschelkalk beds with *Sibirites Prahlada*, Diener. These beds are rather rich in fossils, most of which, however, are in a bad state of preservation. Among the better preserved specimens the following ones may be mentioned:—

Orthoceras, sp. ind.
Nautilus sp. ind. ex. aff. N. Palladii, v. Mojs.
Ceratites subrobustus, v. Mojs.
Danubites Purusha, nov. sp.
Flemingites Rohilla, nov. sp.

This fauna is entirely different from the fauna of the main layer of *Otoceras*,

Woodwardi. The most remarkable species amongst them is *Ceratites subrobustus* represented in my collection by a very fine specimen (figured Pl. XVI). As to its identity with the characteristic species of the Siberian Olenek beds, described and figured by E. v. Mojsisovics, there can be no doubt, as this identity has been acknowledged by the author of the species himself. I consequently propose the name "*subrobustus beds*" for the upper division of the lower triassic rock-series in the Shalshal Cliff, whereas the name "*Otoceras beds*" must be kept for the lower beds, containing the fauna of the main layer of *Otoceras Woodwardi.*

The subrobustus beds are overlaid by the thin bedded earthy limestones with *Sibirites Prahlada*, which, in accordance with Griesbach, I described as lower Muschelkalk in my Memoir on the Cephalopoda of the Himálayan Muschelkalk.

That Griesbach was perfectly correct in uniting this horizon with the Muschelkalk, and in separating it from the lower trias, is proved by the results of a careful examination of the brachiopods, collected by Griesbach and by myself, together with *Sibirites Prahlada.* The following forms occur among them, as Dr. A. Bittner, to whom the description of the brachiopods and bivalves of the Himálayan trias has been entrusted, informs me :—

Rhynchonella Griesbachi, nov. sp.
Spiriferina Stracheyi, Salter.
" aff. *Stracheyi.*
Spirigera, nov. sp.
Retzia, nov. sp.

Rhynchonella Griesbachi is identical with the species called *Rh. semiplecta var.* by Griesbach; it has, however, nothing to do with Munster's species from St. Cassian, but is rather allied to *Rh. trinodosi*, Bittn, from the Alpine Muschelkalk. The *Spirigera* is a very indifferent form. The *Retzia* recalls *Uncinella*, Waagen, by its rudimental area, but no similar form has as yet been described from the Alpine trias. *Spiriferina Stracheyi*, however, is very closely allied to *Sp. fragilis* from the Muschelkalk of Recoaro. Thus the affinities of this fauna point decidedly to Muschelkalk.

A comparison of this section with Griesbach's famous section of the Shalshal cliff, taken about 3 miles S.E. of Rimkin Paiar encamping ground near the confluence of the Chorhoti and Shalshal rivers, clearly shows the remarkable conformity of the stratigraphical sequence.

In Griesbach's section[1], bed 2, the main layer of *Otoceras woodwardi*, is situated immediately above the permian Productus shales. It corresponds to a bank of hard, dark grey limestone of five inches in thickness, and contains an extraordinary number of fossils, amongst them the following cephalopoda :—

Nautilus brahmanicus, Griesb.
Otoceras Woodwardi, Griesb.
" *fissisellatum*, nov. sp.
" *Clivei*, nov. sp.

[1] Geology of the Central Himálayas, Mem. Geol. Survey of India XXIII, pp 145—147.

Otoceras undatum, Griesb.
„ *Draupadi*, nov. sp.
Ophiceras tibeticum, Griesb.
„ *medium*, Griesb.
„ *Sakuntala*, nov. sp.
„ *demissum*, Oppel.
„ *gibbosum*, Griesb.
„ *platyspira*, nov. sp.
Danubites himalayanus, Griesb.

Ophiceras sakuntala still occurs in beds 4 and 6, and *Otoceras sp. ind.* in bed 9, 7 feet 6 inches above the main layer of *Otoceras Woodwardi*. In Griesbach's collection I met with fragments of *Ophiceras*, specifically indeterminable, from bed 29, situated 14 feet above the main layer of *Otoceras*. The beds which overlie this series are perfectly unfossiliferous, but from bed 70, situated 28 feet above the *Otoceras* layer (B_2 Griesbach), specimens of *Ophiceras tibeticum*, Gries., are known, as was stated by Griesbach himself, and as I am able to testify, having examined his collections.

In bed 80, 32 feet above the main layer of *Otoceras Woodwardi*, Griesbach discovered the fragment of an ammonite, which he compared with *Ceratites Wetsoni* Oppel, but which is most probably identical with *Meekoceras fulguratum*, Waagen, from the upper Ceratite limestone of the Salt Range. A second specimen of an ammonite was collected by Griesbach in bed 89, situated 3 feet above the former; this specimen, which he identified with *Meekoceras planulatum*, de Kon., belongs to the genus *Lecanites*. These two fossils are the only ones in Griesbach's collection from the Shalshal cliff, which point to the upper horizon of the Himálayan lower trias, *i.e.* to the subrobustus beds.

The entire thickness of the lower trias is 59 feet in Griesbach's section. As bed 70 still contains a characteristic species of the Otoceras stage, the boundary between the Otoceras and the subrobustus beds must be drawn somewhere between beds 70 and 80, amidst the unfossiliferous shales and limestones. Bed 80 with *Meekoceras* cf. *fulgurato*, Waagen, forms undoubtedly part of the latter stage, the thickness of which may consequently be estimated as about 24 feet.

A second classic locality of the Himálayan lower trias in Painkhánda is the Kiunglung encamping ground at the foot of the Niti Pass. It was visited by Griesbach in 1879 and again in 1882, and by our expedition in 1892. I need not give a detailed description of the stratigraphical structure, as this was most carefully worked out by Griesbach in his memoir (p. 116—122), but will confine myself to pointing out the palæontological evidences for the existence of two separate cephalopod bearing horizons in the lower trias.

The thickness of the Productus shales near Kiunglung E.G.[1] is about 48 feet only. They rest on an eroded surface of the carboniferous white quartzite, and are intimately connected with the next following Otoceras beds. Most of the fossils collected by Griesbach in the Productus shales come from this locality. Amongst them

[1] E. G. stands for encamping ground in this memoir.

are a good number of truly permian types, as for instance *Productus Abichi*, Waag., *Productus cancrini*, Vern., *Productus cancriniformis*, Tschern., *Productus Purdoni*, Dav., etc. The Otoceras beds consist of a sequence of dark rusty weathering limestones, alternating with dark crumbling shales, which pass quite gradually into the micaceous Productus shales below, and into the lighter coloured limestones and shales of the subrobustus beds above. The main layer of *Otoceras* is situated quite close to the upper boundary of the Productus shales, but the leading forms of the genus *Ophiceras* are met with also in the higher beds, up to a height of 9 feet above the *Otoceras* layer, in a far greater number of individuals than in the corresponding beds of the Shalshal cliff. In the collections made at Kiunglung, the following species of cephalopoda are represented :—

Nautilus brahmanicus, Griesb.
Proptychites Markhami, nov. sp.
" *sp. ind.*
Otoceras Woodwardi, Griesb.
" *Parbati*, nov. sp.
Prionolobus (?). sp. ind.
Ophiceras tibeticum, Griesb.
" *medium*, Griesb.
" *Sakuntala*, nov. sp.
" *demissum*, Oppel.
" *serpentinum*, nov. sp.
" *platyspira*, nov. sp.
" *Chamunda*, nov. sp.
Prosphingites Nala, nov. sp.
" *Kama*, nov. sp.

In the Otoceras beds of Kiunglung, *Otoceras* itself is remarkably rare. Here *Ophiceras* predominates much more than in the corresponding beds of the Shalshal cliff. But even the forms belonging to this genus are not equally distributed at the two localities; *Ophiceras serpentinum*, the most frequent form in the Otoceras beds of Kiunglung, is extremely rare in the Shalshal cliff, whereas but very few specimens of *O. Sakuntala*, the leading species of the Otoceras beds of the Shalshal cliff have been collected at Kiunglung.

The subrobustus beds are represented by shaly yellowish grey limestones and dolomites; fossils abound in them, but are almost all crushed and much deformed. Among the better preserved specimens which I collected myself, many fragments of the body chambers of two ammonites occur, which will most probably be found to belong to the genus *Flemingites*, Waagen. Besides them I have to mention :—

Pleuronautilus sp. ind.
Danubites cf. nivalis, nov. sp.
Proptychites aff. obliqueplicato, Waag.

A third locality, where exposures of the subrobustus beds are known to occur, is the southern slope of the Bambanag range, north of the Girthi valley. As has been pointed out by Griesbach, the Bambanag cliffs form the direct continuation of the

Shalshal cliff, and in both of them the same sequence of beds is exposed. In the southern spurs of the ridge, west of the Bambanag peak, this sequence begins with the white quartzite of the carboniferous system rising as a sheer precipice above the glen of the Girthi river. Between the white quartzite and the precipitous escarpment of the Muschelkalk, the Productus shales and the lower trias are exposed, with a thickness of 150 feet. We did not succeed in tracing out the main layer of *Otoceras Woodwardi* at this place, as a good deal of the section is obscured by masses of debris, derived from the perpendicular walls of the Muschelkalk escarpment. Of the Otoceras beds nothing but the unfossiliferous shales and limestones near the lower boundary of the subrobustus beds is visible. The subrobustus beds, however, are perfectly well accessible. They consist of grey limestone beds of 4 to 8 inches in thickness, alternating with black shales. Both in the shales and in the limestone, fossils were found, among them :—

Danubites cf. Purusha, nov. sp.
Flemingites cf. Rohilla, nov. sp.
Lecanites sp. ind.

The richest fauna of the subrobustus horizon hitherto known, was discovered by C. L. Griesbach in 1883, S. E. of the village of Muth in Spiti Memoirs p. 219. This fauna, which has been compared with the Ceratite formation of the Salt Range by E. v. Mojsisovics,[1] is certainly younger than that of the Otoceras stage, which is also developed at this locality.

Griesbach, although giving only a rather cursory description of the stratigraphical position of these beds, particularly remarks, that the ceratites were picked up in the lower triassic series in higher beds than *Otoceras* and other fossils characterising the Otoceras stage. In his collection the fauna of these higher beds can easily be separated from that of the lower ones, as the number of beds is marked on most of the labels accompanying the different fossils, and moreover the matrix is different from that in which the ammonites of the Otoceras stage are embedded.

The subrobustus fauna of Muth comprises the following species of cephalopoda :—

Ceratites Mandhata, nov. sp.
Danubites Purusha, nov. sp.
" *nivalis*, nov. sp.
" *Kapila*, nov. sp.
" *cf. trapezoidalis*, Waagen.
Hedenstrœmia Mojsisovicsi, Diener.
" *sp. ind. aff. Mojsisovicsi.*
Aspidites superbus, Waagen var.
Flemingites salya, nov. sp.
" *Rohilla*, nov. sp.
" *sp. ind. ex aff. F. trilobato*, Waag.
Meekoceras (Koninckites) Yudishthira, nov. sp.

[1] Sitzungsber. kais. Akad. d. Wiss. Wien, CI, 1892, p. 376.

Three species—*Danubites nivalis, D. Purusha, Flemingites Rohilla*—are identical with forms also present in the subrobustus beds of Painkhanda. The matrix in which the cephalopoda are imbedded is also very similar at both localities, consisting of grey, limestone flags, weathering yellow, somewhat concretionary, and reminding one of the German Wellenkalk.

Like the Muschelkalk, the subrobustus beds seem to be rather widely distributed throughout the mesozoic belt of the Himálayas. Among the fossils entrusted to me for description, there are specimens of *Danubites cf. nivalis* from Banda in Kashmir[1] and of *Danubites Purusha* in a light coloured limestone from the southern slopes of Dharma No. XI in the Lissar valley (Johár).

As to the distribution of the Otoceras beds outside the Painkhanda district, we have again to turn to Griesbach's reports, as Stoliczka entirely failed to recognise the lower trias in Spiti during his geological reconnaissance of that country in 1864. It has been pointed out by Griesbach that the same conditions prevailed in Spiti as in Painkhanda throughout the permian and triassic periods. The base of the sequence is everywhere seen to be dark Productus shales with their permian brachiopod fauna, which gradually passes into the lowest triassic beds. Characteristic fossils of the Otoceras stage are quoted by him from different localities, and my examination of his collections fully confirms his statement.

S.E. of Muth in Spiti, below the subrobustus horizon, the Otoceras beds are represented by dark, arenaceous limestones, with a highly interesting fauna, among which the following ammonites occur:—

† *Ophiceras Sakuntala*, nov. sp.
Nannites hindostanus, nov. sp.
" *Herberti*, nov. sp.
Flemingites Guyerdeti, nov. sp.
Danubites sp. ind. aff. rigido, Dien.

A typical fauna of the Otoceras stage is contained in Griesbach's collections from Khár in Spiti, namely:—

Otoceras sp. ind.
† *Ophiceras tibeticum*, Griesb.
† " *serpentinum*, nov. sp.
† " *Chamunda*, nov. sp.
Danubites sp. ind.
† *Nautilus brahmanicus*, Griesb.
" sp. ind.

Fossils of a lower triassic age are also represented in Griesbach's collections from a third locality in Spiti, Kuling in the valley of the Pin river. In this case it seems, however, more difficult to indicate the horizon of every species with certainty, as the labels attached to them only refer to the lower trias in general, without any hint as to the position of the beds, in which the fossils have been collected.

[1] These are the same forms, which E. v. Mojsisovics mentions in his preliminary note (Sitzungsber. Akad Cl. 1892, p. 377) as "very evolute *Ceratitidae* with many volutions, which probably belong to *Dinarites*, but show also a remarkable similarity to *Tirolites*."

† These species are also present in the Otoceras beds of Painkhanda.

The following cephalopoda are attributable with certainty to the Otoceras-stage :—

† *Otoceras Clivei*, nov. sp.
† *Proptychites Markhami*, nov. sp.
† *Ophiceras tibeticum*, Griesb.
† „ *Chamunda*, nov. sp.
Meekoceras sp. ind.
„ *sp. ind. ex aff. plicatili*, Waagen.
† „ (*Kingites*) *Varaha*, nov. sp.
Danubites planidorsatus, nov. sp.
† „ *sp. ind. ex aff. planidorsato.*

With equal certainty *Danubites Purusha* may be considered as coming out of the subrobustus beds, being distinguished from the rest of the fossils by the lighter colour of its matrix. There remains however one species, *Danubites ellipticus*, nov. sp., of which the horizon is doubtful.

Another fauna of the Otoceras stage was discovered by Griesbach on the eastern slopes of the Lissar valley in Johár, most of the fossils having been found in section 4 of Pl. VII. in Griesbach's Memoir on the Geology of the Central Himálayas. This fauna is especially remarkable owing to the predominance of the genus *Danubites*, compared with the rest of the cephalopoda. It comprises the following species :—

Danubites lissarensis, nov. sp.
„ *planidorsatus*, nov. sp.
„ *rigidus*, nov. sp.
„ *Sitala*, nov. sp.
† *Ophiceras Dharma*, nov. sp.
† *Meekoceras boreale*, nov. sp.
† „ (*Koninckites*) *Vidarbha*, nov. sp.

In the upper Lissar valley the subrobustus horizon is also represented by light coloured grey limestones with *Danubites Purusha*.

Leaving the discussion of the stratigraphical features of the Himálayan lower trias, as compared with the development of the lower trias in other regions, to the last chapter of this Memoir, I shall now proceed to the specific description of the Cephalopoda.

All the fossils described and figured hereafter have been collected either by Griesbach or by myself, with the exception of *Ophiceras demissum*, Oppel. I am indebted to Geheimrath K. A. v. Zittel, Director of the Palæontological Museum of Munich, for the comparison of Oppel's type specimens from the Schlagintweit collection with my own material. This is also the place to express my heartiest thanks to Professor William Waagen and Director C. L. Griesbach of the Geological Survey of India, who enabled me to make use of the proof sheets of Waagen's Memoir on the fossils from the Ceratite formation of the Salt Range, and of his type specimens, which the latter most liberally allowed me to compare with my Himálayan collections.

In the following descriptions I shall have to refer repeatedly to Dr. Waagen's and Grierbach's valuable works.

Order: NAUTILEA.

Family: *NAUTILIDÆ.*

Subfamily: NAUTILINÆ.

Genus: NAUTILUS, Breynius.

1. **NAUTILUS BRAHMANICUS**, Griesbach. Pl. I, fig. 1 a, b, 2 a, b, 3. var. **HEXAGONALIS**, Dien. Pl. XX, fig. 2, a, b.

1880. *Nautilus quadrangulus*, Beyr., *var. brahmanicus*, Griesbach, 'Palæontological Notes on the lower Trias of the Himálayas: Records Geol. Surv. of India, XIII, 104, Pl. I., fig. 1-3.

Dimensions.

	Pl. I., fig. 1.	Pl. I., fig. 2.
Diameter of the shell	65 mm.	73 mm.
" " umbilicus	18 "	20 "
Height of the last volution from the umbilical suture	31 "	34 "
" " " preceding whorl	27 "	30 "
Thickness of the last volution	30 "	39 "
No perforation.		

This species, one of the most characteristic of the Himálayan Otoceras beds, was considered by Griesbach to be a mere variety of *Nautilus quadrangulus*, Beyrich,[1] from the trinodosus horizon of the Alpine Muschelkalk. The two species, however, belong to two very different groups, in spite of the similarity in their general shape. *N. quadrangulus* ranges among the forms which are distinguished by an internal position of the siphuncle, whereas the Himálayan species, in which the siphuncle is situated close to the siphonal part of the shell must be placed in the section of *Nautilus Barrandei*, v. Hauer.[2]

In younger stages of growth the volutions overlap each other to a little less than one half of their height, but in later stages they begin to leave the normal spiral, so much so, that in the largest of my specimens (Pl. I, fig. 2) only one third of the penultimate whorl is covered by the last volution.

The transverse section of the whorls is almost trapezoidal, its greatest thickness coinciding with the rounded umbilical edge. The siphonal side is slightly convex in young specimens. It becomes almost flat in more advanced stages and is often provided with a slight depression along its median line. The flat sides are bordered by rounded edges, whilst the rounded umbilical margins are equally well marked. A comparatively high, perpendicular umbilical wall separates the umbilical margin from the umbilical suture. The umbilicus is very deep but, as far as I can judge from my specimens, not perforated. I am, however, bound to say, that in none of my specimens have I been able to trace out the embryonic cell, as the innermost

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[1] *E. Beyrich*,—Ueber einige Cephalopoden aus dem Muschelkalk der Alpen und über verwandte Arten, Abhandl Königl. Akad d. Wissensch. zu Berlin, 1866, Pl. III, fig. 5, p. 137. *E. v. Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz, Abhandl. k. k. geol. Reichs-Anstalt, Wien, X, 1882, p. 284, Pl. LXXXIII, fig. 3, 4.

[2] *F. v. Hauer*,—Cephalopoden von Aussee, Haidinger's Naturwiss. Abhandlgn., Wien, I, 1877, p. 264, Pl. VII, fig. 15–18; Neue Cephalopoden von Hallstatt und Aussee, *ibid.* III, 1849, p. 2, Pl. I, fig. 4 (non fig. 5).

part of the umbilicus is always closed by the tough matrix, in a manner which renders its preparation impossible.

The thickness of the transverse section varies considerably in different specimens. In young individuals the volutions are always remarkably broader than high, but this proportion often changes in more advanced stages of growth. In most of my specimens I observed a very marked tendency to an increase of the thickness of their volutions near the beginning of the body chamber. In the specimen figured in Pl. I, fig. 2, the volution becomes almost trumpet shaped near its anterior termination, the thickness of its transverse section augmenting in proportion to its height. In another specimen the proportion of these two dimensions is as 37 : 31 near the anterior termination of the last volution, one third of the latter forming part of the body chamber. But even in the most compressed specimen (Griesbach's type specimen, Pl. I, fig. 1) near the end of the body chamber, this tendency to increase the thickness of the volution is faintly indicated.

An essential difference between ***N. brahmanicus*** and *N. quadrangulus* is certainly not constituted by a more compressed shape of the latter, as has been suggested by Griesbach. The measurements of a specimen of the Alpine species by E. v. Mojsisovics give the proportion of height and thickness of the transverse section as 24 to 26 mm. to a diameter of 54 mm These numbers correspond exactly with my measurements of the Himálayan specimens.

In some of my specimens the body chamber is partly preserved. It amounts to one half of the last volution in Griesbach's type specimen, no trace of the peristome being yet indicated, whereas the entire body chamber does not surpass one half of the last volution in *N. quadrangulus*.

The surface of the cast is perfectly smooth. The shell is covered with very numerous, delicate striations, which agree in their direction with the sutures, though they are more strongly curved. They run in a falciform line from the umbilical suture towards the upper part of the sides, where they describe a strongly forward bent curve, which on the siphonal side is followed by a much stronger curve, with its convexity turned backwards. This last curve corresponds to the siphonal lobe, but is considerably sharper.

These lines of growth, which form the more prominent part of the superficial sculpture, are intersected by longitudinal striations. The latter are more delicate and numerous than the radial ones. They are continuous and not interrupted. Nor can they be looked upon as a sort of wrinkly-layer (Runzelschicht), as they occur on the body chamber as well as in the chambered parts of the last volution. They seem to be restricted to the siphonal part of the shell, as I have never been able to observe them in fragments of the shell adhering to the lateral parts. Fig. 2b in Pl. I gives a reproduction of this sculpture from remains of the shell adhering to the siphonal part of the specimen, fig. 2 a, near the anterior termination of the body chamber.

The irregular depressions on the surface of the body chamber in Griesbach's type specimen are certainly accidental, as they are only visible on one side of the whorl and have not been observed in any other of my specimens.

Siphuncle.—Rather close to the siphonal part, especially in young specimens, whereas in latter stages of growth it approaches the centre. In the specimen figured in fig. 3 of Pl. I, the siphuncle is situated exactly between the second and last third of the height in the last volution, near the beginning of the body chamber, whereas in the preceding volution its position is only at one sixth of the height of this volution below the siphonal part. In the last volution it is therefore nearer the centre than the siphonal part, whereas the reverse is the case in the penultimate volution.

Sutures.—Almost identical with those of *N. quadrangulus*, but the septa are less distant from each other. The flat lateral lobe is rather deeper than the siphonal lobe. In one of my specimens the presence of a pointed antisiphonal lobe, which has been mentioned by Griesbach, is clearly shown.

Nautilus brahmanicus var. hexagonalis.—A smaller specimen, differing from the rest by the indication of a hexagonal outline, was figured by Griesbach (*loc. cit.* Pl. I, fig. 21, who considered it to be probably only a younger individual of his species. The only difference from the type specimens of *N. brahmanicus* consists in the almost hexagonal shape of the transverse section. Not only is the flat siphonal part bordered by well defined, though rounded, marginal edges, but a second edge is formed by the meeting of the lower and upper parts of the sides under a very obtuse angle. It is, however, only in the body chamber, that this obtuse edge is well marked, whereas the chambered part of the last volution is perfectly similar to the type specimens of *N. brahmanicus.*

I am inclined to consider this specimen to be a variety of the present species, till further researches prove the hexagonal outline of the body chamber to be a constant character. For the moment there seems to me no sufficient reason to separate it from *N. brahmanicus.*

Locality and Geological position.—Number of specimens examined.—Otoceras beds. Shalshal cliff near Rimkin Paiar E.G., 1, Coll. Griesbach; 2, Coll. Diener; Kiunglung E.G., S.W. of Niti Pass, 3, Coll. Griesbach; 2, Coll. Diener; Khar, Spiti, 1, Coll. Griesbach.

The specimen of *N. brahminicus var. hexagonalis*, was collected by Griesbach in the Otoceras beds of Kiunglung.

Remarks.—There is a great resemblance in the general shape of the shell to *Nautilus quadrangulus*, Beyrich. A sufficiently distinct character is indicated by the high, perpendicular umbilical wall in the Indian species, whereas it is rather low and oblique in the Alpine form and by the slight concavity of the siphonal area in *N. brahmanicus.*

A most striking similarity exists between our species and a Siberian one, which I have described from the triassic deposits of the Island Russkij near Vladivostok[1] in the Amur province. This form agrees so perfectly with our species, that I should not hesitate for a moment to unite them, were it not for the different position of the siphuncle, which is situated below the centre of the whorl in the Siberian species.

[1] Mémoires du Comite géologique de la Russie. XIV, No 3. In the press.

Pleuronautilus subaratus, Keyserling,[1] to which *N. brahmanicus* was compared by Griesbach, is very different from the latter species, in spite of the subangular section of its whorls during early stages of growth, as its inner volutions are provided with the sculpture of a true *Pleuronautilus*, straight, radial ribs, intersected by striations.

Among the carboniferous and triassic species of the group of *Nautilus Barrandei*, distinguished by the external position of their siphuncle, there is not one species closely allied to our Himálayan form, but it may, I think, be compared to one of the Salt Range forms from the Ceratite formation belonging to the section of *N. Barrandei*.

2. NAUTILUS SP. IND. EX AFF. N. PALLADII, v. Mojs. Pl. XXIII, fig. 7.

Dimensions.

Diameter of the shell	91 mm.
„ „ „ umbilicus	16 „
Height of the last volution	53 „
Thickness of the last volution	38 „

It is much to be regretted that this form is represented in my collection by so fragmentary a specimen, which does not justify the introduction of a specific name.

The fragment, which is entirely chambered, recalls in its general shape *Nautilus palladii*, v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz Pl. XCII, fig. 2, p. 285). Its transverse section is considerably higher than broad, its greatest thickness coinciding with the rounded umbilical margin. The rather rapidly increasing whorls overlap each other apparently to about one half of their height. The siphonal part is narrow and flatly rounded. The umbilical region is too poorly preserved to say anything of its shape with positive certainty. It seems to be surrounded by a proportionately high and steep umbilical wall.

Siphuncle.—A little above the centre of the volution. I have been able to trace it out in one of the septa near the beginning of the last whorl.

Sutures.—The rounded lateral lobe is less deeply sinuated than in *N. Palladii.* If a siphonal lobe is present, which cannot be made out with certainty, it must be very small and flat.

Locality and Geological position—Number of specimens examined.—Subrobustus beds. Shalshal cliff, near Rimkin Paiar encamping ground, 1, Coll. Diener.

Subfamily: GYROCERATINÆ.

Genus: PLEURONAUTILUS, v. Mojsisovics.

PLEURONAUTILUS SP. IND. Pl. XXIII, fig. 6.

There is only a single very badly preserved specimen of this species in the collection, which reaches a diameter of about 75mm. and consists of air chambers

[1] *A. T. von Middendorf's* Sibirische Reise. IV, I. Theil., p. 250, Pl. IV, fig. 1—3.; *E. v. Mojsisovics.* Arktische Triasfaunen, Mém. de l'acad. imp. des sciences de St. Pétersbourg, ser. vii, XXXIII, No. 6, 1886, Pl. XVI fig. 1, p. 97.

only. As its state of preservation does not allow any exact measurements, I must refer the reader to the figure.

The fragment, though much spoiled and weather worn, is sufficient for the determination of the genus to which it belongs. It must be left in question, whether its elliptical outline is a proper specific character or merely an accidental distortion. The transverse section seems to have been almost rectangular. The volutions overlap each other, but to a very small extent. The umbilicus is remarkably wide, 27mm. to a diameter of 75mm. It cannot be decided, whether the siphonal part was bordered by clearly marked marginal edges. An umbilical edge seems to be well defined in adolescent stages of growth at least, whereas in later stages the lateral parts pass gradually into the steep umbilical wall. This umbilical wall is perpendicular in the inner volutions.

As in *Pleuronautilus* and in *Temnocheilus* in general, the siphonal part is without any sculpture. The lateral parts are covered with strong, radial, slightly curved ribs. There are faint indications of a series of tubercles near the siphonal margin, forming the termination of these ribs, but I cannot affirm this with any approach to certainty.

Siphuncle.—Not known.

Sutures.—The flatly rounded lateral lobes occupies the entire length of the lateral parts. Neither siphonal nor antisiphonal lobes have been observed.

Locality and Geological position—Number of specimens examined.—Subrobustus beds. Kiunglung encamping ground, 1, Coll. Diener.

Remarks.—This species is not adapted for comparison with other forms of *Pleuronautilus* hitherto described, as it is too fragmentary and hardly shows more than some of the essential characters of this genus, which ranges from the permian deposits of Julfa and of the Salt Range up to triassic strata of the carnian facies.

Family: *ORTHOCERATIDÆ.*

Genus: ORTHOCERAS, Breynius.

ORTHOCERAS SP. IND. Pl. XXIII, fig. 4.

In order to prove the presence of this genus in the subrobustus beds of the Himálayas, I have figured the body chamber of an *Orthoceras* from the Shalshal cliff near Rimkin Paiar encamping ground, although otherwise it is not fit for detailed description.

The rarity of *Orthoceras* in the Himálayan trias in general is rather remarkable. This also applies to the upper triassic beds, in which *Orthoceras* species are very scanty, compared with the frequent occurrence of this genus in the Alpine trias.

Order: AMMONEA.

AMMONEA TRACHYOSTRACA.

The principles of the classification of the triassic Ammonea proposed by different authors up to 1893, have been fully discussed by Waagen in his monograph on the Salt Range fossils from the Ceratite formation. Waagen himself considers the two large subdivisions of *Ammonea*, *trachyostraca* and *leiostraca*, introduced by E. v. Mojsisovics in 1882,[1] to be the most practical classification. In my description of the cephalopoda of the Himálayan Muschelkalk, v. Mojsisovics' classification was likewise made use of.

This eminent author meanwhile published (1893) the second part of his monograph on the Cephalopoda of the Hallstatt beds.[2] In the introduction to this, he not only retains his former classification, but gives further characteristics, for the more exact definition of the two subdivisions of *Ammonea*, *trachyostraca* and *leiostraca*. He particularly refers to the sculpture of the shell as being indeed the most prominent, but not the only distinct character of these two groups, which are perfectly empirical, and distinguished from each other by very important peculiarities.

In the *trachyostraca* there are never more than the normal number of principal lobes (three), but often a smaller number; nor do adventitious sutural elements ever occur. The sutures are either ceratitic or brachyphyllic, or in their highest stages of development, dolichophyllic, but never leptophyllic *(Arcestidæ)*, phylloidal, or dimeroidal. Another important character of the *trachyostraca* is constituted by the reduced number and size of the auxiliary lobes and saddles, differing considerably from the large, well individualised principal saddles.

On account of these characters the overwhelming majority of triassic Ammonites may easily be separated into these two subdivisions. As to the Ammonites of the Himálayan Muschelkalk for instance, I have not met with one single form, which could not be attributed with certainty either to the one or to the other of these subdivisions.

In the lower trias the case is, however, different. The remarkable difference between *trachyostraca* and *leiostraca*, which is so conspicuous in geologically younger forms of upper triassic or of Muschelkalk age, is but faintly marked in some of the geologically older types characterised by a ceratitic development of their sutural line. There are several genera belonging to the *leiostraca*, as *Xenaspis*, *Meekoceras*, *Gyronites*, *Ophiceras*, the sutures of which are perfectly identical with those of forms belonging to *Ceratites* or *Danubites*. In all of them the number of the individualised principal lobes is equal, and the auxiliary series is only

[1] *E. v. Mojsisovics*,—Die Cephalopoden der Mediterranen Triasprovinz, Abhandlungen k. k. geol. Reichs-Anstalt, Wien, X, 1882, p. 3.

[2] Abhandlungen, k. k. geol. Reichs-Anstalt, Wien, VI, Part ii, 1893, p. 1.

represented by an umbilical row of indentations, following directly after the second lateral saddle.

These forms can only be grouped together according to the sculpture of their shells. As this latter is sometimes rather insignificant, it is more or less a matter of personal taste whether it ought to be considered sufficiently well marked to attribute the species in question to the *trachyostraca* or not. The decision becomes still more difficult in a few cases where a much sculptured species, which forms decidedly part of the *trachyostraca*, is connected with a smooth one by a series of transitional forms, as is the case in some species of *Danubites*, Mojs., and *Gyronites*, Waag. Within this series the two subdivisions must be distinguished in a rather arbitrary manner.

These transitional groups actually point to a closer relationship, by which the *Ceratitidæ*, one of the two large stems of the *trachyostraca*, seem to be linked to the *leiostraca*. It has been suggested by E. v. Mojsisovics, that *Meekoceras*, Hyatt (*Gyronites*, Waagen),[1] or rather one of its allies may be the presumptive ancestor of the *Ceratitidæ*. This suggestion is corroborated by the discovery of forms in the lower trias of the Himálayas and of the Salt Range, which by reason of their general shape and sculpture, and arrangement of their sutures, may be attributed with equal right to either *Danubites*, *Ceratites* or to *Meekoceras*. In the introduction to *Danubites* I shall have to refer a few forms attributed by Waagen to his genus *Gyronites* (group of *G. plicosus*), which I prefer to look upon as belonging to the *trachyostraca*, in consequence of their distinct circumplicate sculpture, though I must confess, that a similar close relationship seems to exist between them and some other species, apparently derived from *Lecanites*, v. Mojs., which decidedly belongs to the *leiostraca*.

Another instance is furnished by the species described and figured by Waagen as *Meekoceras falcatum*,[2] which shows a most striking affinity in its sculpture to *Danubites himalayanus*, Griesbach. Thus, in my opinion, it ought to be separated from *Meekoceras*, and to be attributed to the *Ceratitidæ*, among which it may be placed somewhere near *Ceratites connectens*, Mojs.[3]

On the other hand, Waagen (*loc. cit.* p. 84) thinks, that it would be more correct to consider the Siberian species *Ceratites multiplicatus*, *C. hyperboreus*, *C. fissiplicatus*, *C. discretus*, for which the group of the "*Ceratites obsoleti*" has been created by E. v. Mojsisovics, rather as belonging also to his new genus *Gyronites* or else to Griesbach's genus *Ophiceras*, than to the *Ceratitidæ*.

All these facts seem to prove that in the lowest triassic deposits of the Salt Range and of the Himálayas, we gradually approach the earliest forms of the *Ceratitidæ*, which are probably very closely related to *Meekoceras*, Hyatt. But there is no genus of the *leiostraca* hitherto known, which might be pointed out with any certainty as the presumptive ancestor of the *Ceratitidæ*.

[1] *Xenodiscus*, v. Mojsisovics, actually corresponds to *Meekoceras*, Hyatt, but not to *Xenodiscus*, Waagen, as the latter genus is now interpreted by its author.

[2] Fossils from the Ceratite Formation, Pl. XXXVI, fig. 4, p. 242.

[3] Cephalopoden der Mediterranen Triasprovinz, Abhandlgn. k. k. geol. Reichs-Anstalt, X, 1882, Pl. III, fig. 10, p. 9.

The beautiful researches on the Arctic Cephalopoda by E. v. Mojsisovics[1] have given full evidence of an uninterrupted evolutional series, which connects the *Dinarites spiniplicati* with the *Ceratites subrobusti*. The gradual passages between the two genera make it perfectly evident that *Ceratites*, characterised by the presence of a normal number of principal lobes, developed from a form with one single lateral lobe (*Dinarites*). In the Otoceras beds of the Himálayas no species provided with only a single lateral lobe has as yet been discovered, although *Danubites*, a subgenus of *Ceratites* with the normal number of two principal lobes, is rather frequent. Nor has any ancestor of *Meekoceras* with a smaller number of principal lobes hitherto been met with, the lowest types of this genus (*Gyronites nangaensis*, Waagen, and *Meekoceras aplanatum*, White) being distinguished by the complete absence of an auxiliary series, though the normal number of principal lobes are present. I therefore think, that the roots, from which both *Meekoceras* and the stem of the *Ceratitidæ* have sprung, following such entirely different lines of evolution, must be searched for in geologically older (probably permian) deposits of the Indian triassic province.

Emile Haug in his remarks on the classification of the permian and triassic ammonites[2] takes another view of the matter. He thinks that the evident affinities which exist between *Meekoceras* and several species of the genus *Ceratites*, may be interpreted in a completely different manner, and he suggests that *Meekoceras* far from being the ancestor of *Ceratites*, is, on the contrary, derived from the latter genus by attenuation of its sculpture, gradual contraction of the umbilicus, and augmentation of the number of auxiliary lobes. But one great drawback regarding this view consists in the fact, that species of *Meekoceras* with rather remarkably developed sutures, existed already in the Otoceras stage of the Himálayas (for instance *M. Hodgsoni*), whereas no true *Ceratites* have as yet been found in these beds, in which the *Ceratitidæ* altogether are only represented by the subgenus *Danubites*.

Haug in his proposed classification of the permian and triassic ammonites, although laying stress on the genetic connection of the single genera, considers the arrangement of the sutures to be the only characters of importance for their distinction. This view I am decidedly disinclined to follow. In accordance with E. v. Mojsisovics and Waagen, I think that, in order to arrive at a natural classification, use will have to be made of *the totality of essential characters*, viz., general shape, sculpture, length of body chamber, sutures, but not of one single character only.

The two large subdivisions in Haug's classification of the permian and triassic ammonites, based, as he pretends, on truly phylogenetic characters, coincide in general with the *Ammonea trachyostraca* and *A. leiostraca*, established by E. v. Mojsisovics. They are called, however, the "*Glyphioceratidæ*" and "*Prolecanitidæ*", as Haug tries to follow their evolutional series from the triassic to the permian faunæ. Considering the grave doubts as to the real evolutional connection of the

[1] *E. v. Mojsisovics.*—Arktische Triasfaunen, p. 19.
[2] *E. Haug.*—Les ammonites du Permien et du Trias, Remarques sur leur classification. Bull. Soc. Géol. de France ser. iii, XXII, 1894, pp. 385–412.

transitional faunæ between permian and triassic times,—neither the fauna of the lower Himálayan trias nor the Cephalopoda of the Salt Range Ceratite beds had been described at the time of Haug's publication—I cannot see proof of his supposed evolutional relations, sufficient to change the terms *Ammonea trachyostraca* and *A. leiostraca* in favour of new names, which in their turn ought to be changed, whenever the evolutional series shall have been traced from *Glyphioceras* and *Prolecanites* to their ancestors.

Family: *CERATITIDÆ*, v. Mojsisovics.

Subfamily: DINARITINÆ, Mojs.

The family of the *Ceratitidæ* is exclusively represented in the Himálayan Muschelkalk by genera derived from *Dinarites*, Mojs., whereas forms belonging to the subfamily of the *Tirolitinæ* do not appear in geologically older beds than the Aonoides stage, in which a few species of *Trachyceras*, Laube, have been collected by General Sir Richard Strachey and were described by Salter, and were recently found by our own expedition in 1892. The appearance of *Trachyceras* in strata of upper triassic age must be explained by immigration of this genus from the Alpine region, as in geologically lower horizons of the Indian triassic province none of the ancestors of *Trachyceras* have ever been met with. As in the Arctic. Pacific region, *Tirolites*, v. Mojs., and all the forms allied to this genus are completely absent in the lower trias of the Salt Range, as well as of the Himálayas.[1] Of the two subfamilies *Dinaritinæ* and *Tirolitinæ*, distinguished by E. v. Mojsisovics among the *Ceratitidæ*, only the first is represented in the lower trias of the Himálayas by the genus *Ceratites* and its subgenus *Danubites*.

It is rather strange that no representative of the genus *Dinarites*, Mojs., has as yet been found in the Himálayan Trias. This genus, characterised by the presence of one single lateral lobe and by the development of an umbilical sculpture, plays a very important roll in the Olenek beds of eastern Siberia. It is also known from the lower trias of the Ussuri district (Island Russkij), and the Salt Range, but it seems to be absent in the Himálayan deposits of the same age. In the latter, no species, with a smaller number of principal lobes than the normal, has hitherto been met with. E. v. Mojsisovics[2] supposed, it is true, that a form from the subrobustus beds belongs to *Dinarites*, but this supposition has not been confirmed by my closer examination, as the form in question is certainly provided with two true lateral lobes, and must be attributed to the subgenus *Danubites*. It will later on be described as *Danubites nivalis*.

[1] I do not think that many palæontologists will agree with Waagen in determining the rather poorly preserved fragment, figured Pl. XXIV, fig. 5, as *Balatonites*. Waagen himself rightly considers this determination as doubtful.

[2] Sitzgsber. kais. Akad. d. Wiss., Wien, CI, 1892, p. 377.

Genus: CERATITES, de Haan.

True representatives of the genus *Ceratites* de Haan—as its diagnosis has been established by E. v. Mojsisovics—do not make their appearance below the upper horizon of the Himálayan lower trias, *viz.*, in the subrobustus beds. Its place is taken in the Otoceras stage by the subgenus *Danubites*.

There are altogether only two species belonging to our genus. One of them must be included in the *circumplicatus* group, whilst the other is identical with *Ceratites subrobustus*, v. Mojsisovics, from the Olenek beds of Siberia.

a. CERATITES SUBROBUSTI.

1. CERATITES SUBROBUSTUS, E. v. Mojsisovics. Pl. XVI., a, b, Pl. XIX, fig. 2.

1845. *Ceratites Middendorffi*, Graf Keyserling: Beschreibung eniger von Dr. A. Th. von. Middendorff mitgebrachten Ceratiten des arktischen Siberiens. Bull. phys-math. de l' Acad. des sciences de St. Pétersbourg, V, No. 11, Pl. II, fig. 4.
1886. *Ceratites subrobustus* E. v. Mojsisovics: Arktische Triasfaunen. Mem. Acad. imp. des sciences de St. Pétersbourg, ser. vii, XXXIII, No. 6, p. 44, Pl. IV, fig. 2, Pl. V, Pl. VI, fig. 1.

Dimensions.

Diameter of the shell		178 mm.
„ „ „ umbilicus		52 „
Height of the last volution	from the umbilical suture	81 „
	„ „ preceding whorl	69 „
Thickness of the last volution		app. 90

The presence of this most characteristic Siberian form in the Himálayan lower trias is one of the most interesting results of the palæontological examination of the rich material collected during the trip of 1892. The identity of the present specimen with the Arctic species has been confirmed by Oberbergrath Dr. E. v. Mojsisovics.

This specimen is among the largest of the genus *Ceratites*, although it does not equal the size of *Ceratites Middendorffi*, Keyserling. Some specimens of the latter species with a diameter exceeding 150 mm. are still entirely chambered, whereas in our specimen, the body chamber is almost entirely preserved, the chambered part of the shell reaching only a diameter of 120 mm. It is certainly a full grown specimen, as may be seen from the difference between the sculpture of the body chamber and of the chambered volutions. This difference is equally well marked in the full grown specimen, figured by E. v. Mojsisovics in Pl. IV, fig. 2.

Among the Siberian specimens of *C. subrobustus* figured by E. v. Mojsisovics, it agrees best with one figured on Pl. VI, fig. 1, although on a considerably larger scale. The volutions are thicker than high, even in the body chamber. They increase rather rapidly, encircling a deep umbilicus, the inner portion of which, however, is not preserved in a satisfactory manner. The whorls overlap each other to about one half of their height. Their involution takes place exactly outside the strong umbilical tubercles, which near the end of the penultimate whorl are still situated almost half way between the umbilical suture and the siphonal margin. As the

innermost volutions are not preserved, or rather as I have not been able to chisel them out of the extremely tough matrix, the polygonal spire inside the umbilicus, which is so characteristic in young individuals of the *subrobustus* group, cannot be observed.

The transverse section of the inflated whorls is somewhat square, with rounded angles. The siphonal part is broad and flat and is separated from the flatly rounded side by a very obtuse marginal edge. The greatest thickness of the volutions coincides with the middle portion of the lateral parts. The latter slope in a gradually increasing curve towards the umbilical suture, the last portion of the umbilical wall being almost perpendicular. As in the Siberian specimen, figured Pl. V, no umbilical edge, nor any lateral aplanation, appears in the body chamber, whereas in the specimen, figured Pl. IV, fig. 2, an umbilical margin and an aplanation of the sides are well marked near the beginning of the body chamber.

Thus the Himálayan specimen combines peculiarities of the two Olenekforms, with body chambers, figured by E. v. Mojsisovics, as the sculpture, but not the general shape of its shell, changes in the body chamber.

To the body chamber belongs exactly one half of the last volution, no trace of the peristome being present, although this cannot have been far off from its anterior termination.

The sculpture of the Himálayan specimen corresponds exactly to the species from the mouth of the Olenek, figured by E. v. Mojsisovics in Pl. VI., fig. 1.

Its principal sculptural elements are the massive, protracted umbilical tubercles, which are seen almost in the middle portion of the lateral parts near the beginning of the last volution, but approach gradually the lower portion of the sides towards its anterior termination. From these umbilical tubercles start bifurcate ribs, which terminate in strong marginal thorns of a circular shape, not protracted or elongated as the umbilical tubercles. The ribs continue, although in considerably reduced strength, across the siphonal area, most of them becoming as it seems dichotomous. The presence of two siphonal ribs joining the marginal thorns is, however, not so clearly marked as in *Sibirites*. They may almost equally well be considered as one single rib, the middle portion of which is but slightly hollow. It must be noticed especially, that the ribs which cross the siphonal area are very delicate, and that they die out completely on the body chamber. The direction of the siphonal ribs is nearly straight, or very slightly curved, their convexity being turned towards the mouth of the body chamber.

In the body chamber the characters of the sculpture are rather different. The ribs rising in the umbilical tubercles gradually die out, and the umbilical tubercles diminish in strength, becoming more elongated. A short distance from the anterior termination of the last whorl the sculpture consists only of a very flat, protracted elevation which passes across the lateral parts in a radial direction.

Whether the sculpture is arranged symmetrically to the median plane of the shell cannot be ascertained, as it is only sufficiently well preserved on one side, but it is most probable, as the marginal thorns actually correspond on the two borders of the siphonal area.

Sutures.—The sutural line is nearly identical with that of the specimen figured by E. v. Mojsisovics in Pl. IV, fig. 2c, with the exception, that no trace of the formation of an auxiliary saddle outside the umbilical suture is observable in the Himálayan specimen.

The siphonal lobe is very deep, and stands considerably lower than the principal lateral lobe. It is divided by a rather high siphonal prominence. There are five dentations at the base of each wing of the siphonal lobe and six at the base of the principal lateral lobe. The points are very strongly developed, especially the basal ones. The upper portion of the high, rounded saddles is entire, the incisions being restricted to the lowest parts of their marginal walls. There is but one bipartite, auxiliary lobe outside the umbilical suture. This is the ordinary number of auxiliary lobes in *Ceratites Middendorffi*, Keyserl., and in most of the representatives of the *subrobusti*.

The siphonal saddle corresponds in its position to the marginal thorns, each of them being encircled by the rounded top of the saddle. The principal lateral saddle coincides with the umbilical tubercles; the second lateral lobe is situated inside the umbilical margin.

No trace of the shell is preserved.

Locality and Geological position—Number of specimens examined.—Subrobustus beds, Shalshal Cliff near Rimkin Paiar E. G. Limestones immediately below the brachiopod bearing earthy beds with *Sibirites Prahlada*, 1, Coll., Diener.

Remarks.—Ceratites subrobustus belongs to a group of forms which is most extensively developed in the lower trias of Siberia near the mouth of the Olenek river. No representative of this group has been met with hitherto in the Alpine trias. In the Himálayan Muschelkalk, however, a species occurs, which is very closely allied to this, differing especially by its more richly serrated sutures. This species I have described and figured in Pl. V, fig. 6 of the "Cephalopoda of the Himálayan Muschelkalk." It may be supposed that *Ceratites subrobustus* is one of its direct ancestors.

The presence of the true *Ceratites subrobustus* in the upper horizon of the Himálayan lower trias is of great importance, as it does not only allow the correlation of this horizon with the Olenek beds of north-eastern Siberia, but also furnishes a distinct proof of the correctness of E. v. Mojsisovics' views, who considered the Olenek beds as lower triassic on palæontological evidence alone.

β. CERATITES CIRCUMPLICATI.

2. (1) Ceratites Mandhata, nov. sp. Pl. XVII, fig. 1.

Dimensions.

Diameter of the shell	120mm.
" " umbilicus	37 "
Height of the last whorl	48 "
Thickness of the last whorl	26 "

It is not without some misgiving that I introduce this new species, the material for which is rather scanty, consisting of only a single fragmentary individual.

As however the characters of the species may be tolerably well recognised from this specimen, which in itself is very interesting, being the only representative of the *circumplicati* among the lower triassic Ceratites of the Himálayas, it seemed desirable to distinguish this form by a proper name.

In its general shape the species recalls several forms from the Himálayan Muschelkalk, belonging to the group of the *Ceratites circumplicati*, as *Ceratites Hidimba* or *C. Visvakarma*, which are described in the second part of this volume (Pl. III, fig. 1, Pl. IV, fig. 2). The shell is flatly disciform with a wide and not very deep umbilicus and compressed whorls.

The transverse section of the whorls is considerably higher than broad and is almost perfectly oval, with a highly rounded siphonal area. The lateral parts are flatly arched, and gradually pass into the siphonal area without intervention of a marginal edge. At the same time they regularly slope towards the umbilical suture, passing likewise gradually into a low but perpendicular umbilical wall. The greatest transverse diameter of the whorls is situated a little below the middle of their height.

One of the most remarkable characters of this specimen is the considerable amount of the egression[1] from its normal spiral line in the last volution. A similar egression was observed by myself in *Ceratites Visvakarma*, although on a more reduced scale. In the anterior termination of the last whorl the latter only just touches the preceding volution, overlapping only its siphonal area. Thus the first impression of our specimen is that of a typical *Danubites.* A closer examination, however, shows that this minimum of involution is restricted to the foremost portion of the last whorl. By carefully splitting the specimen I have succeeded in tracing the amount of involution in different parts of the last whorl. Near the beginning of the latter it amounts to nearly half the entire height of the penultimate volution, the measurements furnishing the following results:—

Height } of the penultimate whorl	11·5 mm.
Thickness } of the penultimate whorl	6 „
Height of the overlapped portion	5·5 „

Unfortunately the sculpture is but partly preserved. It is very simple, consisting only of nearly straight, radial ribs. Near the beginning of the body chamber the shell is so much weathered, that they appear only as flat elevations, but nearer the aperture two ribs are rather well marked and thus allow a partial reconstruction of the actual sculpture. These ribs originate near the umbilical suture, forming a sharpened roof like edge and gradually die out, flattening out towards the siphonal margin. There may have been about 12 to 15 of them in the last volution.

The body chamber occupies rather more than half of the last whorl. The neighbourhood of the margin of the aperture is marked by a considerable lateral contraction of the shell near its anterior termination.

[1] For a definition of this term compare the footnote on p. 14 of the Cephalopods of the Muschelkalk, Pt. ii of this volume.

No trace of the shell is preserved.

Sutures—The sutural line is very similar to that of *Ceratites Kuvera*, Diener,[1] only the auxiliary series is simpler.

The siphonal lobe is rather broad and deep and stands at an equal level with a second lateral lobe. It is divided by a broad, strongly developed, siphonal prominence and distinctly denticulated at its base. The principal lateral lobe is the deepest. It ends like the second lateral lobe in five to six elongated digitations, which are not arranged parallel to each other, but converge towards the centre of the lobes. The auxiliary lobe is short and narrow, but also distinctly serrated. It is followed by a broad, semicircular, auxiliary saddle, the innermost portion of which is divided by the umbilical suture.

The lobes are considerably enlarged at their base, as is the case in *Ceratites Kuvera*. Thus the saddles are narrower at their base and have a somewhat oval or ellipsoidal shape. They are perfectly entire and show a remarkable tendency to bend over towards the umbilicus, whilst their frontal slope is less steeply inclined. The principal lateral saddle is the highest.

Locality and Geological position.—Number of specimens examined.—Sub-robustus beds, S. E. of Muth, Spiti., 1, Coll., Griesbach.

Remarks.—*Ceratites Mandhata* is among the most interesting forms of the *circumplicatus* group on account of its rather conflicting characters. The first group of characters regarding the sculpture of the shell, bring this species near the most simple, lower triassic types of the *circumplicati*, as, for instance, *Ceratites connectens*, v. Mojs. (Cephalopoden der Mediterranen Triasprovinz, Pl. III, fig. 10, p. 9). In the second group of characters, however, with reference to the egression of the body chamber and the arrangement of the sutures, it bears a close resemblance to some forms of the Himálayan Muschelkalk and differs remarkably from the Arctic Ceratites of the *polaris* group.

Better and more extensive materials ought to be available, in order to decide the question whether this species and the Indian representatives of the group of *Ceratites polaris*, Mojs., of the Himálayan Muschelkalk form one evolutional series, as I am inclined to believe.

Subgenus: DANUBITES, v. Mojsisovics.

1893. *Danubites*, E. v. Mojsisovics, Die Cephalopoden der Hallstätter Kalke, Abhandlungen k. k. Geol. Reichs Anstalt, VI, Pt. ii, p. 398.

In his memoir on the triassic fossils from Japan[2] E.v. Mojsisovics suggested that he had erroneously united the group of *Ceratites Floriani* v. Mojs. with his genus *Ceratites*, and that it ought to be removed to the group of the *Ceratites obsoleti*. In 1893 a new subgenus of *Ceratites* was proposed for these two united groups, and was named *Danubites* by the same author.

[1] Pt. ii, Cephalopoda of the Muschelkalk, Pl. V, fig. 2,c.

[2] *E. v. Mojsisovics*, Ueber einige Japanische Trias Fossilien, Beiträge zur Palaeontologie Oesterreich Ungarns und des Orients, herausgegeben von E. v. Mojsisovics und M. Neumayr; VII. 1888, p. 170.

As characters of this new subgenus, volutions which scarcely overlap each other, and of a celtitic surface sculpture, are quoted. The sculpture, which is almost entirely confined to the lateral parts, consists of straight, as a rule single, rarely bifurcated, ribs, which are always interrupted in the siphonal area, sometimes even by a thread like siphonal keel. A good character of the group of *Danubites Floriani* is the unusually large distance between the septa, even in the neighbourhood of the body chamber. But in the *Danubites obsoleti* this character is certainly not of equal importance.

All the species belonging to the subgenus *Danubites* form part of a group of forms which genetically are closely related among each other, and may be easily distinguished from *Ceratites* by these characters. In this case one of the species included by E. v. Mojsisovics in the group of the *Ceratites obsoleti* must, however, be separated from the latter, namely *Ceratites sigmatoideus*, Mojs.,[1] which differs from *Danubites* by more involute whorls, overlapping each other to more than one-third of their height, and by its spiniplicate lateral sculpture, whereas in *Danubites* the sculpture is always of a most decidedly circumplicate type, even in quite young individuals.

The subgenus *Danubites* is rather largely represented in the Himálayan trias. Three species have been described from the Muschelkalk, *Danubites Dritarashtra*, *D. Ambika*, *D. Kansa*, the two last mentioned occurring in the triassic limestone crags of Chitichun, which are of lower Muschelkalk age. Not less than thirteen representatives of this subgenus are known from the lower trias of the Himálayas. Five species occur in the subrobustus beds, seven in the Otoceras beds, in which no other form of the *Ceratitidæ* has been found as yet, while the exact geological position of one species is doubtful.

All the lower triassic forms of this subgenus are of moderate size, none of them attaining so large dimensions as *Danubites Kansa*, Diener, from the triassic limestone of Chitichun, or as *D. Naumanni*, Mojs., (*loc. cit.* Pl. II, fig. 1, p. 169) from the upper trias of Japan. The body chamber probable does not much exceed the length of half a volution. At least no fragments of body chambers of greater length are known to me. In one specimen of *Danubites Sitala* (Pl. XV, fig. 13) and of *D. rigidus* (Pl. XV, fig. 4 a), the peristome is partly preserved, although the shape of the apertural margin is not exactly known. The latter is fairly well indicated in *D. cf. trapezoidalis*, Waagen, in which it describes a falciform curve, which crosses the siphonal part with a forward curvature.

The sutural line is very simple. In some species it seems to remain in an entirely goniatitic stage of development (*D. nivalis*), without any trace of denticulation. The auxiliary series consists of one single auxiliary lobe, which is either serrated or goniatitic, and which in one species only (*D. himalayanus*), is followed by a distinct auxiliary saddle.

The Himálayan lower triassic species may be most conveniently divided into

[1] *E. v. Mojsisovics*, Arktische Triasfaunen, Mém. de l'acad. imp. des sciences de St. Pétersbourg, sér. v XXXIII, No. 6, 1886, p. 24, Pl. II, fig. 10.

three sections according to their sculpture. I prefer to group them according to this character and not according to the rounded or biangular condition of the siphonal area of their whorls, which I consider, in accordance with E. v. Mojsisovics and Waagen, as of very subordinate systematic value.

The first section comprises all the forms, in which the sculpture of the lateral parts remains one and the same in the body chamber, and in the chambered part of the volutions. The second group is characterised by the existence of a remarkable difference in the sculpture of the inner volutions and of the last whorl, especially of its body chamber-portion. The third section is distinguished by a very peculiar sculpture which recalls somewhat that of *Tirolites*, Mojs., the marginal portions of the ribs being more strongly developed than the umbilical ones.

The chief representative of the first section is *Danubites Purusha*, Diener. *Danubites himalayanus*, Griesbach, belongs to the second group, whilst the third section, which by the Tirolitic shape of its lateral sculpture is distinct from the others, and contains only one species, is represented by *Danubites nivalis*, Diener.

Thus we arrive at the following classification of the species which belong to the subgenus *Danubites* :—

α. Group of Danubites Purusha, nov. sp.

1. *Danubites Purusha*, nov. sp., subrobustus beds.
2. *D. ellipticus*, nov. sp., Otoceras beds (?).
3. *D. planidorsatus*, nov. sp., Otoceras beds.
4. *D. sp. ind. aff. planidorsato*, Otoceras beds.
5. *D. rigidus*, nov. sp., Otoceras beds.
6. *D. sp. ind. aff. rigido*, Otoceras beds.
7. *D. cf. trapezoidalis*, Waagen, subrobustus beds.

β. Group of Danubites himalayanus, Griesb.

8. *D. himalayanus*, Griesbach, Otoceras beds.
9. *D. lissarensis*, nov. sp., Otoceras beds.
10. *D. Sitala*, nov. sp., Otoceras beds.
11. *D. Kapila*, nov. sp., subrobustus beds.
12. *D. sp. ind. ex aff. himalayano*, Otoceras beds.

γ. Group of Danubites nivalis, nov. sp.

13. *D. nivalis*, nov. sp., subrobustus beds.

I need hardly say that none of my lower triassic species from the Himálayas can be united with the group of *Danubites Floriani*, v. Mojsisovics, the thread like median keel on the siphonal side, which is common to the representatives of this Alpine group, being entirely absent in all my specimens. To this group, however, belongs *Danubites Dritarashtra* (Cephalopoda of the Muschelkalk, Pl. VIII, fig. 1) from the Muschelkalk of the Utadhura (Johár).

As I have already stated in the discussion of the *Ammonea trachyostraca*, several forms have been referred by Waagen to his new genus *Gyronites*, which I prefer to include in the subgenus *Danubites*, a subject which I will discuss when reviewing the genus *Meekoceras*.

It is especially the group of *Gyronites plicosus*, Waagen,[1] which must be united with this subgenus. This group contains three forms, *Gyronites plicosus*, W., *G. rotula*, W., *G. radians*, W., all of which are characterised by the presence of a clearly marked radial sculpture, which does not cross the siphonal area.

In *G. plicosus* the lateral sculpture consists of single radiating folds, which are perfectly straight and most strongly expressed in the vicinity of the umbilicus, but gradually die out towards the upper portion of the lateral parts. This is exactly the same sculpture as in *Danubites rigidus*, or in *D. sp. aff. rigido*, which latter species seems to be closest allied to the Salt Range species. In *Gyronites rotula*, and in *G. radians* (*loc. cit.* Pl. XXXVIII, fig. 3 a, b, 4 a, b, 5 a, b, and Pl. XXXVIII, fig. 6 a, b, 7 a, b, 8 a, b) the ribs are not straight but slightly falciform. Waagen himself compares these two species to the group of *Ceratites obsoletus* of E. v. Mojsisovics, and suggests that at least three species of this group, *C. hyperboreus*, *C. fissiplicatus*, *C. discretus*, may actually belong to his genus *Gyronites*. *Ceratites* (now *Danubites*) *hyperboreus* especially, is so closely allied to *Gyronites radians*, that it is scarcely possible to distinguish them. "All the differences, which might perhaps be urged, consist in the ribs, which are slightly more falciform, and the external side, which is perhaps a little more narrowly rounded in the Siberian, than in the Indian species."

Thus there is no question regarding the intimate relationship of the group of *Gyronites plicosus*, Waagen, to a series of forms, which were considered by E. v. Mojsisovics as typical species of his subgenus *Danubites*. It only remains to be decided whether the Arctic *Danubites obsoleti* ought to be placed among the *Ammonea leiostraca* or the group of *Gyronites plicosus*, differing from the smooth forms of the typical *Gyronites*, Waagen, by a very distinct sculpture, or whether they ought to be united with the subgenus *Danubites*, which forms part of the *Ammonea trachyostraca*.

As neither the general shape of the shell nor the sutural line afford any characters for distinguishing *Gyronites*, Waagen, from *Danubites*, Mojs., the distinction must needs be made on account of the sculpture. I refer the reader to Pl. VII. of Waagen's Memoir, on which several specimens are figured, which he includes in the genus *Celtites*. In *Celtites subrectangularis*, for instance, the sculpture is certainly not any stronger developed than in *Gyronites radians*, nor is there any reason, why *Gyronites plicosus* should be excluded from the *Ammonea trachyostraca*, its sculpture being as distinct and characteristic, as in many forms, which nobody would hesitate to place in the *Trachyostraca*. If *Danubites* must be separated from the *leiostraca*, a necessity which nobody will doubt, regarding *Danubites naumanni*, *D. Kansa*, *D. Purusha* or *D. Floriani*, this separation can only be made on account of the sculpture, and all the forms characterised by a distinct lateral sculpture, must consequently be united with *Danubites*.

Waagen himself in his introduction to the chapter *Ammonea leiostraca* insists on the systematic value of sculptural elements. "In the *trachyostraca*," he

[1] Salt Range Fossils, Pal. Indica, ser. xiii, II., Fossils from the Ceratite formation, Pl. XXXVIII., fig. 11 a, b.

says (p. 136), "where the shells are already easily distinguishable by their different ornamentation, the chief points of distinction of the genera and species must always be taken from the characters of the sculpture *in the first place*.[1] The case is quite different in the *leiostraca*, where one has to deal always with smooth shells, in which only sometimes low, radial folds are developed."

I agree fully with Waagen, if he considers the configuration of the lobes to be most important characters for a distinction in doubtful cases. I fully agree with him for instance, in considering the genus *Flemingites* to belong to the *leiostraca* on account of the configuration of its siphonal lobe, in spite of a sometimes strongly marked sculpture. I can, however, find no reason for the complete neglect of a very decided sculpture as a character for the distinction of *Gyronites plicosus* and its allies from the *leiostraca*, since in this case this character is the only one, which is available.

I am therefore inclined not to follow Waagen's views in this matter, but to consider the Siberian group of the *Danubites obsoleti* to belong to the present subgenus, in accordance with E. v. Mojsisovics. In this subgenus the group of *Gyronites plicosus*, Waagen, will consequently have to be included. Like the *Danubites obsoleti* of the Siberian Olenek beds, this group belongs to the first section of our Himálayan *Danubites*, which show no change of their sculpture in the last volution.

There is yet another form, which was compared by Waagen to *Gyronites rotula*, and might therefore perhaps form part of the present subgenus. It is the species figured by C. A. White[2] (Pl. 31, fig. 1c), which this author erroneously identified with *Meekoceras aplanatum*, and which Waagen proposes to rename *Gyronites whiteanus*. I am, however, not able to decide the question, whether this form ought really to be placed in the group of *Danubites* (*Gyronites*) *plicosus*, Waagen. The sculpture is but very indistinctly marked in the drawing, although Professor Hyatt in his description (p. 113) states, that "in some specimens there are indications of nodes on the sides, and in some the young until a late period are distinctly ribbed, the ribs being thick straight folds, reaching across the sides, but not up on to the siphonal side." From this description the existence of forms with distinct ribs among the species *Meekoceras aplanatum*, White, may be guessed. These forms probably belong to *Danubites* and not to *Meekoceras*. But whether *Gyronites whiteanus* forms part of them, or may better remain among the *Ammonea leiostraca*, cannot be made out with certainty, as neither the figure nor the description give any clue in this matter.

Later on I shall have to refer to a good many instances which seem to show that a careful revision of the fauna of the Meekoceras beds of Idaho is quite indispensable for a closer comparison of its fossil remains with such of foreign countries, and that from the rather antiquated description of White no exact idea of its Cephalopoda can be gathered. *Gyronites* (or rather *Meekoceras* according to my diagnosis of this genus) *whiteanus*, Waagen, must be left for the moment among

[1] The italics are mine.—C. D.

[2] *C. A. White*,—Contributions to Invertebrate Palæontology No. 5. Triassic fossils of South-Eastern Idaho; XII. Annual Report of the U. S. Geol. Survey for the year 1878, Pt. ii, p. 112.

the species of a doubtful generic position, which may either belong to *Danubites*, or to *Meekoceras*, or even to *Ophiceras*.

If we inquire whether other forms besides those already described should be included in the subgenus *Danubites*, we must turn to the forms which Waagen refers to the genus *Celtites* (p. 69 and following). It is especially the group of *Celtites subrectangularis*, Waagen, to which I allude, whereas the species corresponding to *Celtites epolensis*, v. Mojs., certainly belongs to the genus *Celtites*.

Among the group of *Celtites subrectangularis*, the generic position of this species itself, as well as of *C. armatus* and of *C. multiplicatus*, has been made secure on account of the circumstance, that in several cases the largest part of the body chamber has been preserved, which shows, without doubt, that the apertural margin is still preserved, to a length of nearly an entire volution (*loc. cit.* p. 70). These forms must consequently remain in the genus *Celtites*, although the material in the Salt Range collection is rather badly preserved and the distinction between air chambers and body chambers is rarely possible.

There is, however, one species, *Celtites trapezoidalis* Waagen, (Pl. XXI, fig. 8 a, b, c, p. 76), represented by an excellently preserved specimen, the body chamber of which is not known, which on account of its general shape and sculpture may be attributed to *Danubites*. The involution of its whorls is extremely small and its sculpture restricted exclusively to the lateral parts. "It consists of rather numerous, straight, radial folds, which commence faintly a little above the umbilical suture, are strongest in the middle of the lateral parts, and disappear again towards the rounded-off external edge, without forming the slightest trace of any tubercle. There are 18 to 19 of these folds on the last volution" (p. 77). This is exactly the same sculpture, which we meet with in the species figured Pl. XV, fig. 10. In their general shape and sculpture these two species are so very similar, that I should really be at a loss how to distinguish them. Were it not for the fragmentary preservation of my Himálayan specimen, I should not hesitate to identify it with Waagen's Salt Range species. Their close relationship induces me, however, to remove *Celtites trapezoidalis* from this genus and to place it in the present subgenus.

Another doubtful species seems to be *Celtites dimorphus*, Waagen (Pl. VII, fig. 5 a, b, c, p. 80), founded on a single specimen, in which the sutural lines are not preserved. It is characterised by the different nature of its sculpture on the inner volutions, and on the last whorl, bearing in this respect a remarkable similarity to *Danubites lissarensis*.

The same remark applies to *Celtites* sp. ind., figured by Waagen on Pl. VII, fig. 4 a, b, the lateral sculpture of which strongly recalls *Danubites Kansa* or *D. Ambika* from the triassic limestone crags of Chitichun.

Yet another form which might be compared with *Danubites*, is *Prionolobus buchianus*, Waagen (Pl. XXXV, fig. 5 a, b, c), *non* de Kon. The inner volutions of this species differ remarkably in their sculpture from the outer one, and thus exhibit a very close similarity to *Danubites lissarensis*. The differences between Waagen's type specimen and some of my specimens of *Danubites lissarensis* are of so slight an importance, that I hesitated for a considerable time, whether to consider

them as identical or not. Although I finally decided to make a new species of the Himálayan specimens, their similarity is so striking, that I am obliged to remove *Prionolobus buchianus*, Waagen, from its new genus and to unite it with *Danubites*.

The last group of forms which Waagen himself compared to the *Ceratites obsoleti*, is the group of *Lecanites ophioneus*, comprising besides this species (Pl. XXXVIII, fig. 12 a, b), *Lecanites convolutus*, Waagen (Pl. XXXVII, fig. 10 a, b, c) and *L. laquens*, Waagen (Pl. XXXVIII, fig. 9 a, b, 10). Especially *L. ophioneus* is very similar to *Ceratites* (*Danubites*) *multiplicatus*, v. Mojs., (Arktische triasfaunen, p. 25, Pl. IX, fig. 15), the sculpture of which is, however, considerably stronger, although it is of the same irregular character, consisting of straight radial ribs of uneven strength. Still more striking is the similarity of *Lecanites convolutus* with my *Danubites planidorsatus*, from which it may perhaps be distinguished by the arrangement of its sutural line. I am therefore inclined to include also these forms in the present subgenus, although their ornamentation is less distinct than in the group of *Gyronites plicosus*, Waag.

It must of course always be borne in mind, that *Gyronites*, Waagen, (*Meekoceras* mihi) and the group of the *Danubites obsoleti*, v. Mojs., stand in very close relationship to each other, and that the transitions from the smooth forms of *Meekoceras*, with large umbilici and only slightly overlapping whorls, to the sculptured *Danubites* are very gradual. Thus in reality a distinction between the transitional forms becomes perfectly arbitrary. In such cases only the condition of the sculpture can furnish a character for the diagnosis. The difference between Waagen's view and my own as to the range of the subgenus *Danubites* is consequently of minor importance than may seem at first sight. According to what has just been stated, I transferred all the forms of his genera *Prionolobus*, *Gyronites* and *Lecanites* with a distinct lateral sculpture to *Danubites*. It only needs a look at Pl. XIV and XV of this memoir to prove the desirability of uniting all the forms, so intimately related among each other, under one and the same generic designation. Cases will always be met with, in which the decision, whether the sculpture is sufficiently distinct for a shell to be placed in the subgenus *Danubites*, becomes a mere matter of personal taste. But the great bulk of forms can certainly be distributed among *Danubites* and *Meekoceras* or *Lecanites* on account of the character of their ornamentation.

Having thus explained my views as to the range attributed in the present memoir to the subgenus *Danubites*, I will now proceed to specific descriptions.

a GROUP OF DANUBITES PURUSHA, nov. sp.

1. DANUBITES PURUSHA, nov. sp. Pl. XV, fig. 14, 15.

Dimensions.

Diameter of the shell		46 mm.
" " " umbilicus		23 "
Height of the last volution	from the umbilical suture	14 "
	" " preceding whorl	18·5 "
Thickness of the last volution		13 "

This is a typical species of *Danubites* with a nearly subangular transverse section, a wide and open umbilicus, and a very strong sculpture.

In young individuals the transverse section of the whorls is almost rectangular, with rounded off corners. The proportion of its height to thickness is rather variable, being in the figured specimen as 14 : 13, in a second from S. E. of Muth (Spiti), as 11 : 9, in a third one from Kuling (Spiti), the sutures of which are figured in fig. 15, as 11 : 11. As a rule the whorls are higher than broad and are surrounded by lateral parts, which are but flatly arched. Their greatest transverse diameter is situated in the lower part of the lateral parts.

The siphonal area is broad and flatly rounded, but is not separated from the lateral parts by distinct marginal edges. The sides slope much more rapidly towards the umbilicus than towards the siphonal margin. The umbilical margin is steeply rounded, and bordered by a rather high and steep, but not vertical, umbilical wall.

The volutions overlap each other to a very small extent only, the last whorl covering exactly the broad siphonal area of the penultimate whorl.

The strong, coarse sculpture is entirely restricted to the lateral parts. It consists of simple, straight ribs, arranged radially, or in a direction deviating but very little from the radial one. As the surface is somewhat weather worn in most of the specimens, the ribs as a rule appear obtuse, or rounded above, but from a closer examination of better preserved parts of the shell, it can be made out, that they were originally sharpened into narrow ridges. They occur to the number of 17 to 24 on one volution. Although the pattern of the sculpture remains about the same, on the body chamber and on the chambered part of the shell, the ribs stand generally somewhat closer together near the aperture than at the commencement of the last volution. The sculpture is, however, on the whole not quite regular, the breadth of the intercostal intervals varying to a certain extent.

In the figured specimen less than one third of the last volution forms part of the body chamber. In the specimen from Kuling, the sutural line of which is represented in fig. 15, a little less than one half of the last whorl belongs to it. Fragments of the body chamber from the Shalshal cliff near Rimkin Paiar encamping ground, and from the Pambanag cliffs, which I consider belong to this species, do not exceed one half a volution in length.

Sutures.—Two distinct lateral lobes, and one auxiliary, are present.

The most remarkable character in the arrangement of the sutural line is the unusually depth of the siphonal lobe. By this character our species may be easily distinguished from all the rest of its allies. The siphonal lobe is at least as deep, in some of my specimens even deeper, than the principal lateral one. It is divided by a very low siphonal saddle into two small branches, each of which has two denticulations at its base. These denticulations are much more conspicuous than those observed in the lateral lobes, and may be seen with the naked eye in specimens, where indentations of the principal lateral lobe cannot be made out even by means of a lens (compare Pl. XV, fig. 14 c). The lateral lobes are

either goniatitic or very faintly serrated. The second lateral lobe is considerably smaller than the principal one. The small auxiliary lobe, in the shape of a shallow curve, reaches as far as the umbilical suture.

The saddles have almost parallel sides and are evenly rounded above. The siphonal saddle is the highest. The principal lateral saddle is, however, of nearly equal size.

Locality and Geological position—Number of specimens examined.—Danubites Purusha is one of the most characteristic fossils of the subrobustus beds, being present in Spiti, Painkhánda and Johár.

South of Dharma No. XI., Lissar valley, Johár, 1, Coll. Griesbach; hills south of Kuling, Spiti, 2, Coll. Griesbach; S E. of Muth, Spiti, 1, Coll. Griesbach. Besides these more or less complete specimens (in all 4), fragments of body chambers from the Shalshal cliff near Rimkin Paiar encamping ground and from the Bambanag cliffs (Girthi valley), Coll. Diener.

2. Danubites ellipticus, nov. sp. Pl. XIV, fig. 12, 13.

Dimensions.

	Fig. 13.
Diameter of the shell	33·5 mm.
" " " umbilicus	16 "
Height of the last volution from the umbilical suture	10 "
" " " " " from the preceding whorl	8·5 "
Thickness of the last volution	6 "
Diameter of the shell (at the place of its greatest aplanation)	24 "
Height of the last volution (at the place of its greatest aplanation)	7·5 "
Thickness of the last volution (at the place of its greatest aplanation)	5·5 "
Diameter of the umbilicus (at the place of its greatest aplanation)	10 "

It is its obliquely elliptical shape which makes this species particularly interesting. In my Memoir on the Cephalopoda of the Himálayan Muschelkalk I have fully discussed the reasons, which have induced me to consider the obliquely elliptical outlines of several forms of *Gyronites* and *Japonites* as original ones, following the view of Stoliczka and E. v. Mojsisovics. There is no reason to suppose, that the two specimens, on which this species is founded, owe their elliptical outlines to an accidental deformation in the matrix. They have been brought from Kuling (Spiti) by Griesbach, together with many other fossils, which are perfectly well preserved and do not show any trace of being crushed or squeezed, or otherwise deformed. The discovery of a *Danubites*, distinguished by its strongly developed lateral sculpture, and of an elliptical shape, as is common to several genera of the *leiostraca*, is very instructive and in the meantime favourable to the supposition of a genetic relationship between *Danubites* and *Meekoceras*. A very remarkable species of the latter genus, with similar elliptical outlines, was described and figured by Mojsisovics from the Siberian Olenek beds, under the name of *Xenodiscus* (recte *Meekoceras* or *Ophiceras* (?)) *Karpinskii*.[1]

Omitting the difference, which consists in the elliptical outlines of the Himálayan species, the latter exhibits a remarkable similarity to the Salt Range forms

[1] Arktische Triasfaunen, Mém. de l' acad. impér. des sciences de St. Pétersbourg, ser. vii, XXXIII, No. 6, 1886, p. 75, Pl. XI, fig. 13.

of the group of *Gyronites* (*Danubites* mihi) *plicosus*, Waagen. The flat disciform shape with a very large and shallow umbilicus, the very small involution, and the perfectly oval transverse section remind of *Gyronites* (*Danubites* mihi) *radians*, Waagen (Pl. XXXVIII, fig. 6 a, b, 7 a, b, 8 a, b).

The overlap of the last whorl over the preceding one amounts to not more than one fifth of the height of the latter.

The transverse section of the whorls is perfectly oval. The siphonal area is evenly rounded and passes gradually into the slightly arched lateral parts. Even in young specimens the siphonal part is not flattened, but remains perfectly rounded, as may be observed in the specimen figured Pl. XIV, fig. 12, in which a cross section of the inner volutions is exhibited. Neither umbilical edge nor wall are present. The lateral parts gradually slope towards the umbilical suture, which they meet under an acute angle.

The largest transverse diameter is situated a very short distance below the middle of the height of the whorls.

The sculpture consists of numerous radial ribs (21 to 28 in the last volution), which are very sharp above and almost perfectly straight, with a very slight convexity near the siphonal margin. They do not rise exactly in the umbilical suture, but a little above the latter, which is consequently always surrounded by a narrow smooth rim, free from any sculpture. The ribs are strongest near the middle portion of the lateral parts and gradually die out towards the siphonal margin, where some of them become slightly falciform. They are not equidistant but arranged in a somewhat irregular manner. In the smaller specimen (fig. 13) in one place of the last volution, weaker ribs are intercalated between the stronger ones, as in *Danubites multiplicatus*, Mojs. (Arktische Triasfaunen, p. 25, Pl. IX, fig. 15).

In my specimens not a trace of the shell has been preserved.

Sutures.—The sutural line is too indistinctly visible to describe it in an approximately satisfactory manner. A second lateral saddle is, however, certainly present. Thus the generic position of our species is beyond a doubt.

The smaller specimen consists apparently of air chambers only. In the larger specimen not even rude traces of the sutures are preserved, and it is therefore impossible to state where the body chamber commences.

Locality and Geological position—Number of specimens examined.—Otoceras beds (?). Hills above Kuling, Spiti, 2, Coll. Griesbach. The geological horizon, from which these specimens come, cannot be made out with certainty.

Remarks.—It has been stated already, that *Gyronites* (*Danubites* mihi) *radians*, Waagen, somewhat resembles this species. Another form, which may be compared, is *Danubites multiplicatus*, Mojs. In *G. radians* the ribs are, however, more falciform, whereas in the Siberian species stronger and weaker ones alternate more regularly near the commencement of the last whorl.

Although *D. multiplicatus* seems to be very closely allied to this species, the latter differs decidedly from it by its elliptical outlines, which have not yet been noticed in any *Danubites* hitherto described.

3. DANUBITES PLANIDORSATUS, nov. sp., Pl. XV, fig. 1, 2.

Dimensions.

	Fig. 1.	Fig. 2.
Diameter of the shell	app. 27 mm.	26 mm.
" " " umbilicus	13 "	12 "
Height of the last volution { from the umbilical suture	app. 8 "	8 "
Height of the last volution { " " preceding whorl	?	7 "
Thickness of the last volution	6 mm.	5 "

This species belongs to those forms, which are provided with a distinctly flattened siphonal side, bordered by sharp marginal edges.

In its general shape and sculpture it bears a striking similarity to *Lecanites convolutus*, Waagen (Pl. XXXVII, fig. 10), which species, however, is founded on a rather imperfect specimen.

The whorls are compressed and considerably higher than thick, bordered by flat but very slightly curved lateral parts. The overlap of the last volution over the penultimate one is insignificant. The transverse section is oval, with a flattened siphonal area. The largest transverse diameter corresponds almost exactly with the middle of the height of the volutions. The umbilical margin is marked by a strong curve in the slope of the lateral parts. No distinct umbilical wall is present.

The sculpture is fainter than in *D. ellipticus*. It consists of single radial, rather broad folds, rounded above, not sharp as in the two foregoing species. They are strongest in the vicinity of the umbilical margin and completely disappear near the siphonal edges in the upper portion of the lateral parts.

In the inner volutions the ribs are less distinct, and take the shape of very flat, broad folds, with flatly rounded intercostal intervals.

In the larger of the two figured specimens rather less than one half of the last volution belongs to the body chamber. The smaller specimen is entirely chambered. In two other specimens, which I also refer to this species, no trace of the sutural line is visible, and the length of the body chamber cannot be made out in consequence.

In the specimen figured Pl. XV, fig. 1, part of the shell is preserved. It seems to be perfectly smooth; no traces of growth lines or striations are indicated.

Sutures.—In the two figured specimens the sutural line is well preserved. The siphonal lobe is shorter than the principal lateral one, and is situated at the same level as the second lateral lobe. It is divided by a very short siphonal prominence into two lateral branches, each of which is probably bifid, as has been indicated in fig. 1 c and 2 c. I have, however, not been able to trace out the siphonal lobe sufficiently accurately to state with full certainty that this bifid termination of its lateral branches really exists. The principal lateral lobe is the deepest. In the specimen figured Pl. XV, fig. 2, its base is faintly serrated, as may be seen by means of a magnifying glass. A distinct auxiliary lobe is present outside the umbilical suture.

The saddles have almost parallel sides, which converge very slightly upwards and are evenly rounded above. There is no remarkable difference in the size of the

siphonal and of the principal lateral saddles. The second lateral saddle is considerably smaller, but still of greater importance than in *Lecanites* (*Danubites* mihi) *convolutus*, Waag.

Locality and Geological position.—Number of specimens examined.—Otoceras beds. Hills south of Kuling, Spiti, 3, Coll. Griesbach; south of Dharma No. XI, 1, Coll. Griesbach.

Remarks.—I have already pointed out the striking similarity which exists between this species and *Lecanites* (*Danubites*) *convolutus*, Waag., from the upper Ceratite limestone of Chidru in the Salt Range. Waagen's type specimen is unfortunately of so very fragmentary a character, that it renders a closer comparison of the two species very difficult. The inner volutions of the Salt Range specimen are so weatherworn, that nothing of their sculpture has been left. In the sutural line slight differences seem to exist. In the Salt Range species the siphonal saddle is smaller than the principal lateral one, and the lobe included between them has sides which slightly converge downwards, whereas they are almost parallel in the Himálayan form.

Another difference is constituted by the very small size of the second lateral saddle and by the bifid termination of the siphonal lobe in *Danubites convolutus*, but all these characters are of such minor importance, that one is really at a loss how to distinguish the two forms as long as no better specimens of *D. convolutus* are available. Nor do I dare to identify them, considering the difference of their relative geological position.

4. DANUBITES SP. IND. EX. AFF. PLANIDORSATO. Pl. XV, fig. 3 a, b, 7.

Dimensions.

		Fig. 3.
Diameter of the shell		app. 38 mm.
„ „ „ umbilicus		19 „
Height of the last volution	from the umbilical suture	11 „
	„ „ preceding whorl	11 „
Thickness of the last volution		8 „

There are two specimens of this species in existence, both internal casts with very fragmentary traces of sutures only, and too fragmentary to justify the introduction of a specific name for them.

In its general shape this species recalls the foregoing one, being provided with a wide and open umbilicus and with a flattened siphonal area. The transverse section of the whorls is nearly trapezoidal, the largest diameter coinciding with the slightly rounded, but distinctly marked, umbilical margin. From this the lateral parts converge without curve towards the siphonal area, which is bordered by sharply marked marginal edges. A rather high and perfectly vertical umbilical wall separates the umbilical margin from the umbilical suture.

The volutions only touch each other, overlapping not more than the broad siphonal area of the preceding whorl.

In the specimen figured Pl. XV, fig. 3, the type specimen of the species, whose measurements are given above, the sculpture remains of the same pattern in

the inner volutions, as in the last whorl, which forms already part of the body chamber. In the fragment figured Pl. XV, fig. 7, the sculpture seems to be less strongly defined towards the anterior termination of the body chamber, but the surface of this fragment is so weather worn that it is impossible to decide whether this difference in the strength of the sculpture is an original or a merely accidental one. As this fragment apparently agrees in its other characters with the type specimen, figured Pl. XV, fig. 3, I consider them provisionally as belonging to the same species.

The sculpture consists of straight, radial ribs, which are more numerous and narrower than in *D. planidorsatus.* They commence near the umbilical suture in the form of very faint elevations, and attain the maximum of their strength between the umbilical margin and the middle of the height of the volutions. In the upper portion of the lateral parts they gradually disappear. Although the ribs are narrower than in *D. planidorsatus*, they are not sharp topped, but rounded.

Sutures.—The sutural lines are barely perceptible and it is quite impossible to describe them, but the presence of two lateral lobes may be presumed with tolerable certainty.

In the specimen, figured Pl. XV, fig. 3, the posterior part of the last volution consists of air chambers only, whereas the anterior portion belongs to the body chamber. As the rest of this volution is destroyed, the length of the body chamber cannot be ascertained.

Locality and Geological position—Number of specimens examined.—Otoceras beds. Hills above Kuling, Spiti, 1, Coll. Griesbach (the type specimen); Shalshal cliff near Rimkin Paiar encamping ground, 1, Coll. Diener.

Remarks.—This species may be easily distinguished from *Danubites planidorsatus*, to which it is closely allied, by its trapezoidal cross section, its vertical umbilical wall, and its more numerous and narrow ribs.

Among other species of *Danubites* provided with a flattened, biangular siphonal area, it may be compared to *D. trapezoidalis*, Waagen (Ceratite Formation Pl. XXI, fig. 3, p. 76), but the latter differs by its more involute and more rapidly increasing whorls, the shape of its transverse section, and the absence of any distinct umbilical margin or wall.

It appears unnecessary, to compare our species with *D. Purusha*, as the flattened siphonal area and the trapezoidal cross section make a distinction easy.

5. Danubites rigidus, nov. sp. Pl. XV, fig. 4, 5.

Dimensions.

	Fig. 4.	Fig. 5.
Diameter of the shell	30 mm.	24 mm.
" " " umbilicus	12·5 "	10·5 "
Height of the last volution from the umbilical suture	11 "	8 "
" " " " preceding whorl	?	7 "
Thickness of the last volution	app 7 "	5·5 "

This seems to be a rather small species, as the specimen fig. 4, which corresponds to a diameter of 30 mm., is already provided with the body chamber, the pesristome of which is partly indicated.

The overlap of the last whorl over the penultimate one is inconsiderable, and amounts to a little more than one fifth of the height of the latter.

The height of the volutions increases a little more rapidly than in the last species. The volutions are compressed, considerably higher than broad. Their largest transverse diameter is situated rather below the middle of their height. Their cross section is oval, with a flattened and broad siphonal area, bordered by sharp marginal edges. The lateral parts are distinctly arched. They bend down rather quickly to the umbilical suture, which they meet under an obtuse angle, without any indication of an umbilical margin or wall. Towards the siphonal side the lateral parts slope more gradually and with a flat curve. The siphonal edges are very sharp and equally well defined in the younger as in the adult specimen.

The ornamentation is very characteristic. It consists of very numerous, faint ribs, which become somewhat weaker near the margin of the aperture, without changing their character. These ribs, which rise in the umbilical suture, are only well expressed in the vicinity of the umbilical region and are completely obliterated in the upper portion of the lateral parts, a good distance before reaching the siphonal margins. These low ribs describe a very flat curve with its convexity turned forward and often alternate with perfectly straight ones. They are rounded above and are somewhat more steeply inclined on the side turned to the rear, than towards the front of their convexity.

Even the inner volutions, as far as they are preserved, are provided with this faint but characteristic sculpture. In the larger of the two figured specimens about 25 ribs may be counted in the last volution.

Not the slightest trace of the sutural lines is perceptible in any of my specimens.

In the larger specimen figured Pl. XV, fig. 4, the lowest portion of the apertural margin is indicated in the shape of a sharp line, defining the shell from the neighbouring matrix. In its vicinity a few very delicate lines of growth may be observed, which form a slightly falciform curve. They have been omitted by the draughtsman, in fig. 4 a, owing to their delicacy.

Locality and Geological position—Number of specimens examined.—Otoceras beds. South of Dharma No. XI, Lissar valley, 2, Coll. Griesbach.

Remarks.—This species differs from *Danubites trapezoidalis*, Waagen (Ceratite Formation, Pl. XXI, fig. 3, p. 76), to which it may be compared, by its oval cross section, and more numerous, less distinct, shorter and curved ribs.

6. DANUBITES SP. IND. EX AFF. D. RIGIDO. Pl. XV, fig. 11 a, b.

Of this species there is unfortunately only a single fragmentary specimen in existence. As exact measurements cannot be taken, I must refer the reader to the figure.

The species is considerably more involute than *Danubites rigidus*. It must, however, be placed in the subgenus *Danubites*, the overlap of the last whorl over the preceding one amounting to less than one fourth of the height of the latter only.

The transverse section is similar to that of *Danubites sp. ind. ex aff. planidorsato*, as its largest diameter corresponds exactly to the umbilical margin. The whorls are considerably higher than thick. In the last volution the proportion of its height and thickness is as 12 mm. to 7 mm. The comparatively narrow umbilicus—the term narrow must be understood as in comparison with the relative proportions in other species of *Danubites* only—is surrounded by a tolerably high, steeply inclined umbilical wall, which joins the lateral parts in the shape of a distinct, but slightly rounded-off, umbilical edge.

The lateral parts slope quite gradually, almost without convexity, from the umbilical edge towards the siphonal side. This latter is flat and separated from the lateral parts by an obtuse edge.

The sculpture of the present fragment is very interesting, quite recalling the Alpine *Ceratites Erasmi*, Mojs.[1] It consists of radial, circumplicate ribs, the greatest development of which corresponds to the vicinity of the umbilicus. They commence as very strong, narrow folds, broadening out considerably towards the siphonal margin, near which they disappear completely. As in *Ceratites Erasmi* and in the very similar *Dinarites dalmatinus*, Hauer,[2] the folds are strongly developed in the lower portion of the lateral parts only. Even the number of folds is identical in the two mentioned Alpine, and in our Himálayan species. There are five ribs in our fragment, comprising one half a volution; their total number in the last circuit may consequently be estimated as nine, the same as in *Ceratites Erasmi* or in *Dinarites dalmatinus*.

Not even the slightest trace of the sutural lines is preserved. I am therefore not perfectly sure of the generic position of our species. The close similarity of its sculpture to *Dinarites dalmatinus* might perhaps indicate a real genetic relationship, which would place this species in the genus *Dinarites*, but as the sutures are not known, I cannot decide the question. I prefer, however, to consider this form as belonging to *Danubites* on account of its affinities to *Danubites rigidus* and to *Gyronites* (*Danubites* mihi) *plicosus*, Waagen. To these two forms it is certainly more closely related regarding its involution than to any *Dinarites* hitherto described, the volutions overlapping each other in *Dinarites dalmatinus* to a very considerable amount, whilst their overlap in this species is much smaller. In this respect it is a true *Danubites*, and I consequently leave it in this subgenus till better material allows the question of its generic position to be decided in a more satisfactory manner.

[1] *E. v. Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz. Abhandlgn. k.k. Geol. Reichs-Anstalt, X, 1882. Pl. XL, fig. 13, p. 48.

[2] *F. v. Hauer*, Cephalopoden der unteren Trias der Alpen; Sitzgsber. K. Akad. d. Wiss. Wien, math. nat cl., LII, 1865, p. 615, Pl. II, figs. 3, 4; *E. v. Mojsisovics*, Cephalopoden der Mediterranen Triasprovinz, p. 8, Pl. I, figs. 7, 8.

Locality and Geological position—Number of specimens examined.—Otoceras beds. S. E. of Muth, Spiti, 1, Coll. Griesbach. The original label indicates bed 2, the main layer of *Otoceras Woodwardi* and its allies, as the horizon in which the specimen was found.

Remarks.—The striking similarity which this species exhibits in its sculpture, and also in the shape of its transverse section, to *Ceratites Erasmi* has been pointed out above. As there are no sutures perceptible, the only essential difference consists in the involution, the overlap of the volutions being much more considerable in the Alpine species from the *binodosus* horizon of the Muschelkalk. The similarity to *Dinarites dalmatinus* is only a little less distinctly marked. To the differences by which our species may be easily distinguished from *C. Erasmi*, the rectangular shape of the cross section of *Dinarites dalmatinus* must be added.

Among the Salt Range forms, *Gyronites* (*Danubites* mihi) *plicosus*, Waagen (Ceratite Formation, Pl. XXXVIII, fig. 11), represents a similar type, although it is readily distinguished from the present species by a wider umbilicus, a rounded siphonal area and more numerous ribs. The character of the ornamentation is, however, very similar. It is described by Waagen as follows:—

"The sculpture of the shell is very characteristic. It consists of single radiating folds, which are generally strongly expressed in the vicinity of the umbilicus. They commence as very high, strong folds just at the margin of the umbilical wall, but remain so only for a short distance. Near the middle of the whorls they are already much weaker, and on the outer third they disappear again, without reaching the external part. The folds are always quite straight, without any distinct bend. There are 18 of them on one circuit."

Apart from the greater number of the radial folds or ribs, their sculptural character is exactly the same as in the species from the Himálayan trias. They are a little stronger in the latter. Nobody, I think, would be inclined to include it in the *leiostraca* on this account, but in this case *Gyronites plicosus*, provided with an almost equal sculpture, cannot remain in this genus, but must I consider, be separated from it and be placed among the closely allied forms of the subgenus *Danubites*.

7. Danubites cf. trapezoidalis, Waagen. Pl. XV, fig. 10 a, b.

1895 (?) *Celtites trapezoidalis*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. xiii. II. Fossils from the Ceratite Formation, Pl. XXI, fig. 3 a, b, c, p. 76.

Dimensions.

Diameter of the shell		27 mm.
" " " umbilicus		11·5 "
Height of the last volution	from the umbilical suture	10 "
	from the preceding whorl	app. 9 "
Thickness of the last volution		6·5 "

Among the fossils collected by C. L. Griesbach in the subrobustus beds of Spiti is a single specimen of a *Danubites*, which appears to be so closely related to *Celtites* (*Danubites* mihi) *trapezoidalis*, Waagen, from the upper Ceratite limestone of the Salt Range, that I hesitated for a considerable time whether I ought not

to consider them as identical. It is only the bad state of preservation of the sutures of my Himálayan specimen which induces me not to do so, as better specimens may perhaps prove slight differences in the arrangement of the sutural line.

In general shape, involution and sculpture my specimen bears a most striking similarity to *Danubites trapezoidalis*. The transverse section of the whorls is very characteristic. It is considerably higher than broad, and of an almost trapezoidal outline. The siphonal part is flat, or but very slightly arched, and separated from the lateral parts by an obtusely rounded edge. Thus, according to the shape of its siphonal area, the specimen would belong to the group of the "*semirotundati*," Waagen, being no longer decidedly triangular

In the posterior portion of the last volution the lateral parts are slightly arched as in *Danubites planidorsatus*. Near the peristome, however, they become almost perfectly flat, their largest transverse diameter remaining of almost equal length from the siphonal margin to the middle of the height of the last volution. In Waagen's type specimen, which I was able to compare with my own, exactly the same conditions prevail. Near the commencement of the last volution a slight curve is still perceptible in the outlines of the lateral parts, but near its anterior termination the lateral parts join the siphonal area under a right angle. It is, however, perfectly clear that they do not converge towards the umbilical side from the siphonal margin, but remain parallel for a considerable distance. In this respect the exaggerated drawing (Pl. XXI, fig. 3 b) must be corrected, as it does not represent the actual conditions of the cross section in a satisfactory manner.

The configuration of the umbilical region fully agrees with Waagen's description. "Near the umbilicus the lateral parts bend inside in a short, narrow curve, to meet the umbilical suture; but there exists no umbilical edge, nor distinct umbilical wall. The elevation of the lateral parts above the umbilical suture is but very small, so that the umbilicus itself appears rather shallow."

The overlap of the last volution over the preceding one is very small and does not amount to one full millimetre; it is, however, difficult to measure it exactly in the specimen at my disposal

The sculpture consists of numerous, straight, radial folds, which are narrower than in *D. planidorsatus* and more strongly developed than in *D. rigidus*. They reach nearer to the periphery than in the last mentioned species, but are likewise entirely restricted to the lateral parts. Around the umbilical suture a narrow rim, is left free from any sculpture. The ribs only rise a short distance above the umbilical suture, as in *D. ellipticus*. They attain their greatest strength near the middle of the lateral parts and terminate rather abruptly before reaching the siphonal margin.

The ribs apparently become fainter in the body chamber than they are in the chambered parts of the shell, but the character of the sculpture remains unchanged. As the inner volutions of this specimen have been partly destroyed, none of their sculpture is seen. About 19 ribs may be counted in the last volution, the same number as in Waagen's type specimen.

Sutures.—Of the sutures only very imperfect traces are preserved, which are not fit for description.

The entire body chamber is preserved, comprising a little more than one half of the last volution. The apertural margin is fairly well indicated, describing a falciform curve, similar to the apertural margin of *Ophiceras demissum*, Oppel, (Pl. XIV, fig. 2, a) or of *Ophiceras gibbosum*, Griesb., (Pl. IX, fig. 7 a). It recalls the transitional mouth borders of *Danubites Nicolai*, Dien., from the lower trias of the Ussuri district (eastern Siberia), which will be described in the Memoires du Comité Géologique de la Russie XIV, No. 3, Pl. II., fig. 1 a. This apertural margin follows in its lower portion to the lateral sculpture, but crosses the siphonal area in the shape of a falciform forward bent curve.

Locality and Geological position—Number of specimens examined.—Subrobustus beds. S.E. of Muth, Spiti, 1, Coll. Griesbach.

Waagen's type specimen was collected in the very lowest beds of the upper Ceratite limestone, just above the Ceratite sandstone.

β Group of DANUBITES HIMALAYANUS, Griesbach.

8. (1) Danubites himalayanus, Griesbach. Pl. XIV, fig. 14 a, b, c.

1880. *Ophiceras himalayanum*, Griesbach, Palæontological notes on the Lower Trias of the Himálayas, Records, Geol. Surv. of India, XIII, Pt. 2, Pl. III, fig. 8, p. 111.

1886. *Ceratites himalayanus*, E. v. Mojsisovics, (*non C. himalayanus*, Blanford): Arktische Triasfaunen Mém. de l'acad. impér. des sciences de St. Pétersbourg, sér. vii, XXXIII, No. 6, p. 20.

Dimensions.

Diameter of the shell	40	mm.
" " " umbilicus	16	"
Height of the last volution from the umbilical suture	14	"
" " " preceding whorl	12	"
Thickness of the last volution (near the beginning of the body chamber)	6·5	"
Corresponding height of the last volution	10·5	"

This species is founded on Griesbach's type specimen, the only one which has been collected hitherto.

Griesbach united the species with his newly created genus *Ophiceras* on account of its identical outlines, transverse section, and sutures. E. v. Mojsisovics transferred it to the *trachyostraca* on account of its sculpture, and included it in his group of the *Ceratites obsoleti* (now *Danubites*). Waagen mentions *Ophiceras himalayanum* among the species, which might perhaps form part of his genus *Gyronites*, but he abstains from expressing a positive opinion on this subject.

I prefer to follow the view adopted by E. v. Mojsisovics. *Ophiceras*, Griesbach which most certainly constitutes a proper genus, and *Gyronites*, Waagen (*Meekoceras* mihi, *pro parte*) share with *Danubites*, Mojs., the evolute shell, consisting of comparatively low whorls, not greatly overlapping a wide umbilicus, simple ceratitic sutures, and a short body chamber. The only essential difference is constituted by the strongly developed lateral sculpture of *Danubites*. As this character is clearly indicated in *Ophiceras himalayanum*, Griesbach, it must be removed from Griesbach's genus and be placed among the group of *Danubites*.

In its general shape, especially in the transverse section of its volutions, this species strongly recalls *Ophiceras medium*, Griesb., or *Ophiceras Sakuntala*. The cross section is cardiform. Its largest diameter exactly corresponds to the umbilical margin. From this latter the lateral parts gradually converge in an extremely flat curve towards the siphonal margin, which is not sharply defined, but only marked by a very obtuse, rounded off, angle. The siphonal area is perfectly rounded. The umbilical margin is sharply defined, forming a slightly rounded edge from which a proportionately high and steeply inclined umbilical wall descends towards the umbilical suture. This umbilical wall is, however, very low in the inner volutions; the umbilicus consequently appears to be rather shallow, but from the commencement of the last volution the umbilical wall rapidly increases in height.

The volutions overlap each other to about one fifth of their height, but considerably less than in the two mentioned species of *Ophiceras*, amounting in them to one third or even to half of the height of the penultimate whorl.

In the inner volutions as far as they may be examined, traces of a lateral sculpture are indicated, but it is only pronounced in the last volution. In the posterior portion it consists of strong, falciform ribs which are broadly rounded above, whilst flattening out gradually towards the siphonal margin. They rise exactly in the umbilical edge, and are strongest in the middle part of the sides. Thus the greatest diameter of the volution in the intercostal intervals does not coincide completely with their greatest transverse diameter in the sculptured parts of the shell.

There are about ten ribs present on one half a volution.

In its arrangement this sculpture recalls that of *Danubites hyperboreus*, v. Mojsisovics (Arktische Triasfaunen p. 26, Pl. IX, fig. 16, 17), but in the Arctic species the ribs are not only more numerous, but are as a rule narrower, and some of them become even sharpened above and inversely imbricated. In our species, on the contrary, they are broad, rounded and slope with an equal inclination to the rounded intercostal intervals, both to their front and back.

The umbilical wall remains entirely smooth and has no sculpture.

The system of sculpture in the body chamber is quite different from that prevailing in the chambered part of the last volution. The ribs disappear almost completely near the commencement of the body chamber and change into very delicate, somewhat irregular folds, which are likewise S-shaped, but are of an equal strength from the umbilical edge to the siphonal margin. Near the anterior termination of the body chamber only one stronger rib appears, rising in a protracted, umbilical bump. This rib probably precedes the peristome, as it is immediately followed by a sort of contraction of the shell, which as a rule indicates the neighbourhood of the aperture.

Near the anterior termination of the body chamber, part of the shell is preserved. Its surface is covered with numerous, delicate growth lines, which correspond in their direction to the ribs in the chambered parts of the last volution, and to the thin folds in the body chamber portion.

About half of the last volution belongs to the body chamber, and I believe not much has been broken off.

Sutures.—The arrangement of the sutural line is very similar to that in *Ophiceras medium*, Griesb., or in *Ophiceras Sakuntala*, but not perfectly identical. In these two species only one single auxiliary lobe is present, which forms a finely serrated line descending to the umbilical suture. In this species, however, a distinct, though incomplete, auxiliary saddle follows after a rather small and short auxiliary lobe. In no other species of the lower triassic *Danubites* of the Himálayas has a similar character of the auxiliary series been noticed.

The siphonal lobe is situated a little higher than the principal lateral lobe. It is rather broad, bordered by strongly converging marginal walls and divided by a short siphonal prominence. There is no indentation in the centre of the latter, as has been shown by Griesbach in his drawing of the sutural line of *Ophiceras medium* (Pl. III, fig. 9, b.). Each of the two lateral branches of the siphonal lobe is bipartite at its base. The principal lateral lobe is the deepest. It is rather narrow and elongate, and provided with numerous denticulations at its base, scarcely perceptible, however, without a magnifying glass. The second lateral lobe is considerably smaller, with a well rounded base, in which a few denticulations may be discovered by means of a lens. The auxiliary lobe forms a small, rounded arch, which is quite goniatitic.

The siphonal and the principal lateral saddles are of almost equal size. Their sides are somewhat skew shaped, sloping towards the siphonal part and parallel to the umbilical suture on the reverse side. This sloping tendency of the principal saddles is likewise expressed in several species of Griesbach's genus *Ophiceras*. The second lateral saddle is broad and short. The auxiliary saddle, the inner portion of which is divided by the umbilical suture, is very low and shallow.

Locality and Geological position—Number of specimens examined.—Otoceras beds. Three miles south of Rimkin Paiar encamping ground, Shalshal cliff, 1, Coll. Griesbach.

Remarks.—Danubites himalayanus is a very characteristic species on account of its strong S-shaped sculpture, which disappears almost altogether on the body chamber. I do not know of any other Himálayan species of *Danubites*, with which one might advantageously compare it with.

This is the proper place to mention a very interesting species of *Danubites* from the lower trias of the Ussuri district (eastern Siberia), which, although different, shows a close similarity to *D. himalayanus*. This species will be described and figured as *Danubites Nicolai*, Diener, in the Mémoires du Comité Géologique de la Russie, XIV, No. 3, Pl. II, fig. 1. It was collected by the Russian mining engineer Iwanow in the triassic sandstones of the Island Russkij, in beds which are most probably homotaxial with the Himálayan Otoceras stage. In general shape, involution, arrangement of the sutural line, and character of the sculpture on the chambered portion of the shell, the two species are almost identical. Slight differences consist in a less decidedly cordiform cross section, in the somewhat lesser strength and

number of ribs (8 on the last half circuit) and in the later appearance of an auxiliary series in the Siberian form. The only essential difference is the sudden change of the sculpture of the body chamber of *D. himalayanus*, which does not occur in *D. Nicolai.* In the latter species, on the contrary the last ribs, preceding immediately the peristome, are even more strongly developed and differ from the rest by their marked forward bent curve, which they describe before reaching the siphonal margin.

Among the triassic species from the Salt Range, Dr. Waagen has especially compared *Gyronites* (*Danubites*, mihi) *rotula*, Waagen (Pl. XXXIII, fig. 3 a, b, 4 a, b, 5 a, b,) with *Danubites himalayanus.* The affinity is, however, not a very close one. *D. rotula* may be easily distinguished from our species by the presence of a biangular siphonal area in adolescent stages of growth, by its wider umbilicus, its narrow ribs and also by the persistence of the lateral sculpture on the body chamber.

But there is a striking similarity in the system of the sculpture, between *Danubites himalayanus* and a species from the Ceratite sandstone, which is described and figured by Waagen as *Meekoceras falcatum* (Pl. XXXVI, fig. 4, p. 272).

I have pointed out in my introductory remarks, that Dr. Waagen compares this form with *Meekoceras mushbachianum*, White, from the Meekoceras beds of Idaho, and that he includes it among the *Ammonea leiostraca* in spite of its very remarkable and strong sculpture, which is perceptible already on the inner volutions, corresponding to a height of the whorl of 5 mm. only. This sculpture consists of broad, falciform ribs, which are strongest near the middle of the lateral parts and disappear near the siphonal margin. There are 20 to 22 of these falciform ribs on one whorl, up to the commencement of the body chamber. On the latter the sculpture changes abruptly. The strong, broad ribs are supplanted by very numerous and delicate folds of a similar falciform arrangement. The sutural line differs from *D. himalayanus* by the presence of a broad, serrated siphonal lobe, but the auxiliary series is identical in the two species. But the Salt Range species cannot be placed in the subgenus *Danubites*, as its volutions overlap each other to a rather considerable extent, the overlap of the last whorl over the preceding one amounting to two fifths of the height of the latter.

Among the *Ammonea trachyostraca*, *Meekoceras falcatum*, Waag., may perhaps be correlated advantageously with *Ceratites connectens*, v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz p. 9, Pl. III, fig. 10). The striking similarity of its sculpture to that of *Danubites himalayanus* seems, however, to merit special notice.

9 (2). Danubites sp. ind. ex aff. himalayano. Pl. XIV, fig. 10.

Dimensions.

Diameter of the shell		48 mm.
„ „ umbilicus		22 „
Height of the last volution	from the umbilical suture	15 „
	„ „ preceding whorl	13 „
Thickness of the last volution		11 „

The only specimen of this Himálayan species is scarcely fit to be specially described, owing to weathering, and I am bound to confess, that a good deal of its sculpture, as represented in the drawing, is only a rather conjectural restoration. The following brief description will give an idea of the characters of this species, as far as they can be made out from the fragmentary specimen which is at my disposal.

In general shape the species reminds of *Danubites himalayanus*, but seems to be provided with a wider umbilicus. The transverse section is not so decidedly cordiform, the siphonal area being more broadly rounded. The largest transverse diameter still corresponds to the umbilical margin, which is less sharply marked than in the foregoing species. In the inner volutions the umbilical edge seems to be perfectly rounded. The umbilical wall is steeply inclined.

The overlap of the last volution over the penultimate whorl is a little less than the fourth part of the height of the latter.

The sculpture consists in single, radial ribs, which are either perfectly straight, or slightly bent forward near the siphonal margin. They originate in the umbilical margin, and are strongest in the immediate vicinity of the umbilical region. They seem to be rather broad and coarse, and rounded above. As far as can be made out it seems that the posterior half of the last whorl had about ten ribs.

The sculpture of the anterior part of the last volution, which most probably belongs to the body chamber, can only be conjectured from a few traces of ribs, interrupted by the rough, weather worn surface of the cast. From these traces I presume that the ribs themselves become less strong, and that in the meantime the intercostal intervals get considerably narrower towards the aperture. But I must confess that an absolute evidence of this character cannot be obtained, and that the system of sculpture, represented in the figure, is not based on direct observation.

Sutures.—Not known.

Locality and Geological position. Number of specimens examined.—Otoceras beds. South of Dharma No. XI., Lissar valley, 1, Coll. Griesbach.

Remarks.—I have placed this species provisionally near *Danubites himalayanus* on account of the supposed change in the sculpture of the last volution and of a remarkable similarity in the general appearance of the shell. But better materials must be awaited, before a closer comparison of their respective characters can be attempted.

10 (3). DANUBITES LISSARENSIS, nov. sp., Pl. XIV, fig. 8, 9, 11 a, b, c.

Dimensions.

		Fig. 11.
Diameter of the shell		33 mm.
„ „ „ umbilicus		16 „
Height of the last volution	from the umbilical suture	11 „
	„ „ preceding whorl	9·5 „
Thickness of the last volution		7·6 „

This is one of the most characteristic species of *Danubites* which occur in the Otoceras beds of the Lissar valley (Johár), and at the same time one of the most

interesting on account of its very close relationship to ***Prionolobus buchianus***, Waagen (*non* de Kon.) from the lower Ceratite limestone of the Salt Range.

In general shape and involution the species recalls *Ophiceras demissum*, Oppel.[1] It is flatly disciform with rather compressed whorls and a wide umbilicus. The overlap of the last volution over the penultimate one amounts to about one fourth of the height of the latter—considerably less than in *Ophiceras demissum*. The transverse section is very similar to that of *Danubites hyperboreus*, v. Mojsisovics (Arktische Triasfaunen Pl. IX, fig. 16, 17, p. 26). The lateral parts run from the middle of their height nearly parallel to the rounded umbilical margin, whilst they slope distinctly towards the siphonal margin. They pass quite gradually into the rounded siphonal area. No trace of any edge or obtuse angle marks the place where they join the latter. The umbilical margin forms an obtusely rounded-off edge, which is separated from the umbilical suture by a comparatively high, steeply inclined, umbilical wall. The umbilical wall of the inner volutions is equally well marked. The shape of the umbilicus is consequently not shallow, as in *D. ellipticus*, or in *D. planidorsatus*, but rather like that of *D. Purusha*.

The sculpture is very characteristic and entirely different on the inner volutions and the last whorl. The decided change, which the sculpture undergoes, does not coincide with the posterior termination of the body chamber, as it does in *D. himalayanus*, but begins apparently at earlier stages of growth. In the specimen figured in Pl. XIV, fig. 11 a, for instance, it is very clearly marked, although the last whorl is still entirely chambered.

The inner volutions are covered by straight, radial ribs, which run from the umbilical margin in an almost perfectly equal strength and breadth as far as the umbilical suture of the last whorl. These ribs are considerably narrower than the intercostal intervals which separate them. About nine to ten ribs may be counted on one circuit. The intercostal intervals are nearly twice as broad as the ribs themselves, measured along the umbilical suture of the last volution. This system of sculpture resembles remarkably that in a Siberian species of *Danubites* from the lower trias of the Ussuri district, which I am describing in the Mémoires du comité Geologique de la Russie (XIV, No. 3, Pl. I, fig. 7 a, b, c); but in this species the sculpture persists also in the last volution.

The sculpture of the last whorl is transformed into very numerous and flat, slightly falciform folds, which are stronger developed near the umbilical region, than in the upper portion of the lateral parts, and gradually die out and flatten out near the siphonal margin. Not less than 18 to 20 of these folds may be counted on one-half a circuit. On the lower portion of the lateral parts the folds are nearly radial in direction, it is only on the upper portion of the sides, that they describe a slightly falciform curve with its convexity turned backwards.

In the two specimens, figured Pl. XIV, fig. 8, 9, almost all which remains of

[1] *A. Oppel*,—Ueber ostindische Fossilreste aus den secundären Ablagerungen von Spiti und Gnari Khorsum in Tibet: Palæontologische Mittheilungen aus dem Museum des königl. bayrischen Staates, I, 1865, Pl. LXXXVI, fig. 1, p. 290.

the last volution, forms part of the body chamber. In the first mentioned specimen, the last sutural line corresponds to the second rib, indicated in the drawing. Almost exactly one half a volution belongs therefore to the body chamber. The specimen figured Pl. XIV, fig. 11, is entirely chambered.

No trace of the shell is preserved in any of the specimens.

Sutures.—The sutural line is well preserved in the specimen, figured Pl. XIV, fig. 11. It is very much like that of *Ophiceras Sakuntala*, differing from that of *D. himalayanus* by the presence of one single auxiliary lobe.

The siphonal lobe is much shallower than the principal lateral one and terminates in two branches, each of which is bipartite. At the base of the deep and narrow principal lateral lobe small denticulations are visible to the naked eye, whereas in the second lateral and in the short auxiliary lobe they can only be made out by means of a magnifying glass. The siphonal and the principal lateral saddles have almost parallel sides. The latter saddle surpasses the first one in height, even to a more considerable extent, than is indicated in the figure. They are evenly rounded above. The auxiliary lobe is strictly confined to the umbilical wall. The greater part of the second lateral saddle is situated outside the umbilical margin and on the lateral parts, whereas the greater part of the siphonal saddle is situated outside the siphonal area.

Locality and Geological position—Number of specimens examined.—Otoceras beds. South of Dharma No. XI., Lissar valley, Johár, 4, Coll. Griesbach.

Remarks.—As has been mentioned before, a striking similarity exists between *Prionolobus buchianus* (Waagen, Ceratite Formation Pl. XXXV, fig. 5), and our species. The few differing characters in the two species are of such minor importance, that the one may be, if not identified, at least considered a mere variety of the other.

First of all I must express my doubts as to the identity of Waagen's type specimen with *Prionolobus buchianus*, de Koninck.[1] Waagen himself has alluded to the difficulty of deciding which species was really understood under M. de Koninck's name. I even believe that no palæontologist will ever be able to recognise the species from a drawing which is not only most imperfect, but certainly erroneous. I cannot consequently agree with Waagen in applying this name to a form with a decidedly different involution, whilst no auxiliary lobe of the shape drawn in de Koninck's figure (fig. 4 a,) is present. My opinion is, that the name *Prionolobus buchianus*, de Kon.—this species is evidently a *Prionolobus* on account of its sutural line—ought to be exclusively reserved for the specimen, described and figured by de Koninck, and that the name should not be transferred to any other form of the Salt Range trias.

In general shape, involution, sculpture and arrangement of the sutural line *Prionolobus* (*Danubites*, mihi) *buchianus*, Waagen, agrees almost perfectly with our specimens. In Waagen's drawing, it is true, the overlap

[1] *L. de Koninck.*—Quart. Journ. Geol. Soc., XIX, p. 13, Pl. VI, fig. 4; Fossiles paléozoiques, récueillis, dans l'Inde, Liège, 1863, p. 9, Pl. VI, fig. 4.

of the last volution over the preceding one seems to be much larger than in *D. lissarensis*. But Waagen's type specimen itself, which I was able to compare with my own, does not show any trace of so considerable an overlap. Nor does its state of preservation permit a well founded conjecture in this respect, only so much of the shell being actually preserved, as is marked by a lighter shading in the drawing.

As regards the sculpture the similarity is but little less remarkable. The inner volutions of *Prionolobus buchianus* Waagen, up to a diameter of about 30 mm. bear single knob like folds, which are strongest on the umbilical edge and elongated towards the umbilical suture of the following volution. There are about ten such knob like folds on one circuit. On the last volution the sculpture is of exactly the same character as in the Himálayan species, only the number of folds seems to be smaller—20 to 26 on one whorl.

The differences in the sutural line are quite insignificant. The terminal branches of the siphonal lobe exhibit a tripartite arrangement and the second lateral saddle is quoted by Waagen as reaching somewhat higher up than the siphonal saddle. This is indeed the case in a few sutures of Waagen's type specimen, but in the rest of the septa the tops of the two mentioned saddles stand either at an equal level, or the siphonal saddle is even a little higher than the second lateral one. In the description of *Ophiceras* the great individual variety in the size and shape of the different sutural elements in one and the same specimen will have to be quoted. Thus the slight differences in the sutural lines of the two species in question seem to me to be of no importance whatever.

The only points of difference, which may perhaps be found sufficient for keeping up the Salt Range form as a proper species, are the knob like characters of the folds on the inner volutions, and the greater number of folds on the last whorl.

Dr. Waagen's specimen was collected in the lower part of the lower Ceratite limestone.

Another Salt Range species, the sculpture of which may in some respect be compared to that of *Danubites lissarensis*, is *Celtites* (*Danubites*?) *dimorphus* Waagen (Pl. VII, fig. 5, p. 80). The inner volutions of this species are ornamented by a few and broad folds, whereas on the last whorl the sculpture consists of numerous, radial ribs which are much fainter and lean over towards their front. In the rest of their characters the two species are widely different, but I need not enter into a detailed comparison.

Whether *Celtites dimorphus*, Waagen, actually belongs to the subgenus *Danubites* is very doubtful on account of the shape of its siphonal part, which, according to Dr. Waagen's description, is traversed by faintly developed folds. In the figure 5 b the strength and number of these transverse folds is rather hypothetical, as the siphonal area in Waagen's fragmentary type specimen is so badly preserved that it is barely possible to decide whether these folds have not been interrupted along the siphonal part.

11. (4) DANUBITES SITALA, nov. sp. Pl. XV, fig. 12, 13.

Dimensions.

Diameter of the shell		41 mm.
" " " umbilicus		21 "
Height of the last volution	from the umbilical suture	11·5 "
	" " preceding whorl	10·5 "
Thickness of the last volution		9 "

This species is characterized by a very large umbilicus, with numerous, rounded whorls, whose general appearance somewhat recalls *D. dritarashtra* from the upper Muschelkalk of the Utadhura (Cephalopoda of the Muschelkalk Pl. VIII, fig. I).

The overlap of the last whorl over the penultimate one is very small. The transverse section of the volutions is an elongate oval. The umbilical and siphonal margins are rounded off completely. The lateral parts are very flatly arched but pass quite gradually with increasing convexity into the rounded siphonal area and into the low umbilical wall. The largest transverse diameter of the volutions corresponds to the middle of their height.

As in the preceding species, the sculpture is remarkably different on the inner volutions from that of the last whorl. As in *Danubites lissarensis*, the change of the lateral sculpture does not coincide with the commencement of the body chamber, but begins near the anterior termination of the penultimate whorl. On the inner volutions the sculpture consists of straight, radial ribs, which are strongest near the middle part of the sides and are separated by intercostal intervals of the same breadth as the ribs themselves. This system of sculpture reminds of *Danubites cf. trapezoidalis* Waag. (Pl. XV, fig. 10). In the last volution the sculpture is transformed into very numerous delicate folds, which are strongly bent forward near the siphonal margin, and are only interrupted in the middle part of the siphonal area, any trace of a median siphonal keel being, however, absent.

These folds on the last volution, which occur to a number of 25 to 30 on one half a whorl, are neither of equal strength nor direction. Frequently weaker folds, which are situated close to each other, are intercalated between the stronger ones.

Another sort of irregularity which is chiefly developed in the specimen figured Pl. XV, fig. 13, consists in the falciform shape of several ribs, which run from the umbilical suture in a strongly forward bent curve as far as the middle of the sides, where they describe a gently backward turned curve, followed by a third one, turned in reverse direction near the siphonal margin. Thus the folds assume a decided S-shape, as in *Danubites fissiplicatus*, v. Mojsisovics, or in *D. discretus*, v. Mojsisovics (Arktische Triasfaunen, Pl. IX, fig. 18, 19, p. 26, and Pl. IX, fig. 20, p. 27). Some of these folds, which are strongest near the middle part of the sides are directly imbricated,[1] *i.e.*, they gently slope backwards, but are abruptly cut off on their front side.

[1] *E. v. Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlgn. k. k. geol. Reichs-Anstalt, X, 1882, p. 11.

In none of the specimens does more than one half of the last volution belong to the body chamber. In the specimen, figured Pl. XV., fig. 13, the body chamber is almost entirely preserved. The peristome is indicated by a sudden contraction of the shell at its anterior termination, but of the apertural margin itself no trace is visible.

Sutures.—The sutural line, which is fairly well preserved in two specimens, is very similar to that in ***D. planidorsatus*** (Pl. XV, fig. 1 *c*, 2 *c*).

The siphonal lobe is broad and short, situated on an equal level with the second lateral lobe. Whether its terminal branches end in a single point only or are bipartite cannot be made out with certainty. The principal lateral lobe is the deepest and is provided with denticulations, which are clearly visible to the naked eye. The saddles do not differ considerably in size. They slope decidedly towards the siphonal part, the margin turned towards the umbilicus being the steeper ones.

The second lateral lobe is faintly serrated. The sutural line descends from the second lateral saddle in an evenly rounded curve to the umbilical suture, and forms a small auxiliary lobe.

Locality and Geological position—Number of specimens examined.—Otoceras beds. South of Dharma No. XI., Lissar valley (Johár), 4, Coll. Griesbach.

Remarks.—Danubites Sitala may be easily distinguished from all the rest of its congeneric species, by its wide umbilicus and remarkable sculpture; in no other species of ***Danubites*** does a similarly large number of folds occur on the last volution.

12. (5) Danubites Kapila, nov. sp. Pl. XV, fig. 16.

Dimensions.

Diameter of the shell		37 mm.
" " " umbilicus		19 "
Height of the last volution	from the umbilical suture	9·5 "
	" " preceding whorl	?
Thickness of the last volution		9 mm.

This species is also distinguished by a wide umbilicus and very slowly increasing volutions, which overlap each other to a very small extent only, although the specimen does not permit an exact measurement of the extent of the overlap.

The transverse section of the whorls is rather square with rounded off edges. The lateral parts are but very flatly arched. In the adolescent stage the siphonal margin is perfectly rounded, whereas in the anterior portion of the last volution it is marked by an obtusely rounded edge. The umbilical margin is distinctly defined, and separated from the umbilical suture by a steep, almost vertical, umbilical wall. The volutions are almost as broad as high. Their largest transverse diameter corresponds to the middle of the lateral parts.

There is only one specimen in existence and none of the inner volutions are preserved. In the last volution the sculpture on the chambered portion differs from that on the body chamber, to which a little more than one half of the volution belongs.

The sculpture of the chambered part of the last whorl consists of perfectly straight, narrow, radial ribs, which originate near the umbilical margin, and are strongest a little below the middle of the height of the lateral parts. They are separated by intercostal intervals, which are twice to three times as broad as the ribs themselves. The latter become somewhat broader near the siphonal margin and terminate rather abruptly.

The body chamber is covered with considerably weaker and more numerous ribs, standing more closely to each other, but exhibiting otherwise the same characters as in the chambered parts of the last volution.

Sutures.—In their general shape and arrangement similar to those of *D. Purusha*. The siphonal lobe is on the same level as the principal lateral one. Its terminal branches are probably bipartite, at least they do not end in a single sharp point. At the base of the principal lateral lobe a few sharp denticulations are visible. The siphonal saddle is the largest. The second lateral saddle is situated at the umbilical margin. It is very doubtful, whether a rudimentary auxiliary lobe is really present, as has been hypothetically indicated in the figure, but the second lateral saddle is extremely small, and probably does not fill up the entire umbilical wall.

Locality and Geological position—Number of specimens examined.—Subrobustus beds. S.E. of Muth, Spiti, 1, Coll. Griesbach.

7. Group of DANUBITES NIVALIS, Dien.

13. (1) Danubites nivalis, nov. sp. Pl. XV, fig. 17, 18, 19.

Dimensions.

Diameter of the shell	28 mm.
" " " umbilicus	14 "
Height of the last volution { from the umbilical suture	8 "
Height of the last volution { " " preceding whorl	7·5 "
Thickness of the last volution	8 "

In his preliminary note on the triassic cephalopod faunæ of the Himálayas E. v. Mojsisovics[1] especially mentions, among the lower triassic fossils, "some evolute *Ceratitidæ* with numerous whorls, which will probably be found to belong to the genus *Dinarites*, but are very remarkable on account of their similarity with *Tirolites*." This species, to which Mojsisovics alludes in his remark, must, however, be placed in the subgenus *Danubites*, as it is provided with two lateral lobes and saddles, and one auxiliary lobe.

The general shape of the species is disciform, with numerous whorls and a wide open umbilicus. The transverse section is somewhat square, with rounded edges. The volutions are about as thick as they are high, even in adult specimens. The lateral parts are almost perfectly flat. The siphonal area is broad, but very slightly arched and passes gradually into the lateral parts, where they are free from any

[1] *E. v. Mojsisovics*,—Vorläufige Bemerkungen über die Cephalopodenfaunen der Himalaya-Trias. Sitzungsber. Kais. Akad. d. Wiss. Wien, math. nat. Classe, CI. 1892, pt. i, p. 377.

sculpture, while in the sculptured parts an obtusely rounded edge is formed between the broad, elevated marginal terminations of the ribs, and the flattened siphonal area.

The umbilical margin is sharply defined, taking the shape of an obtusely rounded off edge. It is surrounded by a low, but vertical umbilical wall.

In consequence of the small height of the umbilical wall the umbilicus is not deeply sunk, but rather flat.

The sculpture is very characteristic. It differs on the body chamber from the chambered part of the volutions.

In the young stage the whorls are already covered with thick, broad folds, interrupted by broad, rounded intervals. In the chambered part of the last volution the sculpture is most distinctly developed. Strong ribs originate near the umbilical edge and gradually increase in breadth towards the siphonal margin, without diminishing in thickness. Thus a broad elevation is formed near the siphonal margin, imitating somewhat the marginal sculpture of a few species of *Tirolites*, for instance, *Tirolites Darwini*, Mojs. (Cephalopoden der Mediterranen Triasprovinz, Pl. II, fig. 13, Pl. III, fig. 1, p. 73) or *Tirolites Smiragini*, Auerb. (Pl. LXXXI, fig. 1, 2, p. 73). Marginal thorns or tubercles are, however, completely absent, even in younger stages of growth. In this respect a remarkable difference prevails between this species and a true *Tirolites* of the *spinosus* group. Even in the two species of *Tirolites* referred to, which represent a very high evolutional stage of this genus, the inner volutions are characterised by the presence of marginal thorns, whereas the ribs originating in them are faintest in the vicinity of the umbilicus. Regarding the strong umbilical development of the ribs, I do not think the question can be raised seriously, whether *Danubites nivalis* should be considered as derived from *Tirolites*, in spite of a general similarity in their sculpture.

In the body chamber the ribs are less strongly developed and gradually become more numerous. Their broad, marginal elevations completely disappear and near the anterior termination of the body chamber the sculpture barely differs from that in *Danubites Kapila*.

The ribs do not cross the siphonal area, which is perfectly smooth in most specimens. But in the specimen, figured Pl. XV, fig. 19, at a few points of the siphonal area very slight contractions are visible. They correspond to the intercostal intervals and cross the siphonal area in the shape of a broad band with a convexity turned forward.

The ribs are not imbricated and their cross sections are perfectly symmetrical. They slope from their rounded tops with the same angle on either side, to the intercostal intervals. On the chambered portion of the shell there are ten to each whorl. Near the anterior termination of the body chamber their number is nearly doubled.

At a few places on the siphonal area of the cast may be observed very delicate transverse striations, as indicated in the figure 19 b. Like the contractions already referred to, these striations describe a gentle curve with their convexity bent forward. No trace of the shell is preserved in any of the specimens.

In the specimen figured Pl. XV, fig. 19 the length of the body chamber amounts to a little less than half a volution, but the peristome is not preserved. The specimen figured Pl. XV, fig. 18 is entirely chambered, whereas a fragment of the body chamber only is figured in Pl. XV, fig. 17.

Sutures.—Almost identical with those of *D. Purusha*. No trace of the slightest denticulation is indicated at the base of the lobes, which are perfectly goniatitic.

The siphonal lobe is the deepest. Its terminal branches are sharply rounded off below. The saddles are rather broad. The siphonal saddle is the largest. From this they gradually diminish in size towards the umbilical suture. One rounded auxiliary lobe is situated at the umbilical wall.

The siphonal saddle is entirely restricted to the broad siphonal area, whereas the principal lateral lobe corresponds to the siphonal margin.

Locality and Geological position—Number of specimens examined.—Subrobustus beds. South east of Muth, Spiti, 6, Coll. Griesbach; Kiunglung encamping ground, south of Niti Pass, 1, Coll. Diener.

There are several fragmentary specimens from Banda in Kashmir in the Himálayan collection, which in spite of their bad state of preservation have been identified with our species by Mojsisovics. They may probably belong to it, but the material is too fragmentary to pronounce a definite opinion.

Remarks.—Both the sculpture and the thick, square cross section of the whorls are so characteristic in this species that, even in fragments, it can be easily distinguished from other species of the same genus.

B. AMMONEA LEIOSTRACA.

Suborder: ARCESTIDEA, Waagen.

Family: *ARCESTIDAE*, Waagen.

Subfamily: ARCESTINAE, v. Mojsisovics.

Genus: PROSPHINGITES, v. Mojsisovics.

1886. *Prosphingites*, E. v. Mojsisovics: Arktische Triasfaunen, Mémoires de l' acad. impér. des sciences St. Pétersbourg, sér. vii, XXXIII. No. 6, p. 64.

The genus *Prosphingites* was proposed in 1886 by v. Mojsisovics for a species from the Olenek beds of north eastern Siberia, agreeing perfectly in its shape and in the length of its body chamber with the upper triassic genus *Sphingites*, v. Mojsisovics,[1] but differing from the latter by its ceratitic sutures and by the absence of a second lateral lobe. To this species, *Prosphingites Czekanowskii*, Mojs. (Pl. XV, fig. 10, 11, 12, p. 64), a doubtful one was added by the same author in 1888, which had been collected by Baron E. von Toll in the shaly

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[1] *E. v. Mojsisovics.*—Das Gebige um Hallstatt, Part I. Abhandl. k. k. geol. Reichs-Anstalt, VI, 1873, p. 88 (Group of *Arcestes coangustati*); Cephalopoden der mediteranen Triasprovinz, *ibid.*, X, p. 164.

limestones of the Magyl rocks near the mouth of the Jana (Siberia) together with *Meekoceras* (*Beyrichites*) *affine*, *Hungarites triformis* and a few other ammonites of Muschelkalk age. This species was described by Mojsisovics in his memoir "Ueber einige arktische Trias Ammoniten des nördlichen Sibirien" (Mémoires de l' académie imp. des sciences de St. Pétersbourg, sér. vii, XXXVI, No. 5, Pl. III, fig. 11, p. 17). In 1892 the same author, in his preliminary note on the triassic cephalopod faunæ of the Himálayas, announced the presence of *Prosphingites* in the Otoceras beds of Kiunglung.

In the Otoceras beds of Painkhanda the genus *Prosphingites* is actually represented by two forms, *P. Nala* and *P. Kama*, which are very closely allied to each other, but differ considerably from the Siberian species. In the subrobustus beds of the Himálayas the presence of this genus is still doubtful.

1. Prosphingites nala, nov. sp. Pl. I, fig. 4 a, b, Pl. VII, fig. 13 a, b, c.

Dimensions.

		Pl. I, fig. 4.	Pl. VII, fig. 13.
Diameter of the shell		29 mm.	31 mm.
" " " umbilicus		14 "	14 "
Height of the last volution	from the umbilical suture	10 "	11 "
	" " preceding whorl	7·5 "	8·5 "
Thickness of the last volution		16 "	21 "

This species is distinguished by very thick, slowly increasing whorls, which overlap each other to a small extent only, and by a wide, deep umbilicus. In its general shape it recalls *Sphingites meyeri*, v. Klipstein [1] from the lower and middle Carnian stage of the Alpine trias, or still more of *Sphingites bacchus*, Mojs. (Das Gebirge um Hallstatt, Pt. I. Pl. L, fig. 6, 7, p. 89), from the *Lobites ellipticus* beds of the Roethelstein (Salzkammergut). With the latter species especially, it agrees both in the extraordinary thickness of the volutions, even in later stages of growth, and in the remarkable preponderance of the siphonal area.

The transverse section is always much broader than it is high. In some specimens it is almost twice as broad. The thickness of the volutions coincides with the breadth of the siphonal area, the largest transverse diameter corresponding to the sharp siphonal margin. The lateral parts slope from this perfectly sharpened marginal edge in an almost vertical, but very slightly arched, uninterrupted wall, towards the umbilical suture.

The siphonal area is broadly convex and provided with a very obtuse median ridge. This median ridge becomes distinctly marked in the outer volutions only, whereas in the inner ones, up to a diameter of 12 mm., it is not yet indicated. In the innermost volutions which I have been able to chisel out, in the specimen from which the sutural line has been taken in Pl. VII, fig. 13c, the siphonal area forms a regular, broadly rounded arch, without any trace of a median ridge, as in young specimens of *P. Czekanowskii*. The median ridge in the siphonal area consequently appears to be a character which is acquired in later stages of growth only.

[1] *A. v. Klipstein*, Beiträge zur geologischen Kenntniss der östlichen Alpen, p. 121, Pl. VII., fig. 2; *E. v. Mojsisovics*, Das Gebirge um Hallstatt, Part I, p. 69, Pl. LVIII, fig. 7, 8.

The involution does not take place near the siphonal margin, but somewhat outside the latter. Thus in the inner volutions parts of the siphonal area are exhibited in the shape of narrow bands, sloping outwards from the sharp marginal edge.

The umbilicus is very deep in consequence of the great thickness of the volutions.

The casts are free from sculpture, but the shell, which in some of the specimens is partly preserved, is covered by very delicate striations, describing a slightly backward turned curve from the umbilical suture to the marginal edge, whereas they are turned forward in the siphonal area. This condition is clearly indicated in Pl. I, fig. 4a, whilst in this respect fig. 4b does not give a correct idea, because the striations are erroneously interrupted near the median ridge, whereas they ought to be represented as passing the latter in a regular curve.

Sutures.—The vertical projection of the periphery of the penultimate whorl touches the second lateral lobe in the last volution. Thus this species is provided with two lateral lobes, followed by one auxiliary one. In *Prosphingites Czekanowskii* one single lateral lobe only exists. In the diagnosis of the genus this character must be eliminated now as a generic one.

The sutures are entirely ceratitic, as in the Siberian species. The siphonal lobe is broad and divided by a rather large siphonal prominence. Its terminal branches are distinctly bipartite. It stands a little higher only than the principal lateral lobe. The two lateral lobes are situated at an equal level and are provided with sharp denticulations below.

The principal lateral saddle is larger than the siphonal one. The second lateral saddle is small and arch shaped, whereas the other saddles are elongated with parallel sides.

The lateral lobes and the faintly serrated auxiliary lobe are on the same level. Another auxiliary saddle just beginning, is divided by the umbilical suture.

In the specimen, figured Pl. I, fig. 4, the last volution belongs entirely to the body chamber, but the margin of the aperture is not preserved.

Locality and Geological position—Number of specimens examined.—Otoceras beds. N.W. of Kiunglung encamping ground, S.E. of Niti Pass, 4, Coll. Griesbach.

Remarks.—The young specimens of this species are somewhat similar to *Prosphingites Czekanowskii* Mojs., but in later stages of growth the difference between the two species is very remarkable. The Siberian species acquires high and compressed whorls, whereas they remain thick and low in the Himálayan form. Another difference between them is constituted by the arrangement of the sutural line. *P. Czekanowskii* is provided with a single lateral lobe only, a very deep siphonal lobe and a high siphonal saddle, exceeding in size the principal lateral saddle.

In general shape this species seems to be more closely allied to *Sphingites bacchus*, Mojs., the sutural line of which is unknown, but from its affinity to *Sphingites Meyeri*, Klipst., it may be guessed that its sutures are decidedly leptophyllic.

I observed a fragment of the siphonal area of an ammonite from **Banda in** Kashmir in the Himálayan collection, which most probably belongs to the genus *Prosphingites*, but not to the present species. The fragment comprises the median portion of a broadly rounded siphonal area with the siphonal, and principal lateral lobes, and with the adjoining saddles. The rest of the specimen is so thoroughly imbedded in the tough matrix, that all endavours to chisel it out have failed absolutely. By its outlines it must belong to a species of the *Arcestidæ* or *Ptychitidæ* with very thick whorls. The ceratitic sutural line decidedly points to a species of the genus *Prosphingites*, but in consequence of the scanty materials at my disposal I cannot prove this suggestion.

The fragment is derived from the same beds in which the weather worn specimens of *Danubites cf. nivalis* occur, which E. v. Mojsisovics mentioned in his preliminary note on the triassic cephalopod faunæ of the Himálayas.

2. Prosphingitis kama nov. sp., Pl. I, fig. 5.

Dimensions.

Diameter of the shell	32 mm.
" " " umbilicus	14 "
Height } of the last volution	10 "
Thickness } of the last volution	16 "

This species is very closely allied to the preceding one. In their involution, in the shape of the umbilicus, and in the arrangement of the sutural line, the two species agree. Their chief difference consists in the triangular shape of the siphonal area and in the convex shape of the lateral parts in the form under description.

The volutions, which apparently overlap each other to the same extent as in *P. Nala*, are considerably thicker than high, and of an almost trapezoidal cross section. Their largest transverse diameter coincides with the sharp siphonal margin. The preponderance of the siphonal area over the lateral parts is scarcely less distinctly marked than in *Sphingites bacchus*, Mojs., and in the preceding species. The cross section of the siphonal area takes the shape of a rectangular triangle. The right angle is formed by the two sides of the siphonal part, which meet in a very sharp, slightly elevated ridge. I am not even quite certain whether the latter was not provided with a low median keel.

The lateral parts bend distinctly towards the umbilical suture from the sharp siphonal margin. Their uppermost portion, adjoining the siphonal margin, is not steeply inclined, but the slope gradually increases towards the umbilicus and terminates in a vertical wall, which borders the umbilical suture.

As in *P. Nala*, the involution takes place somewhat outside the siphonal margin of the overlapped whorl. The shape of the deepened umbilicus is consequently similar in the two species.

The figured specimen consists of air chambers only.

Sutures.—The second lateral lobe is divided into two by the siphonal margin. As the projection of the periphery of the penultimate whorl exactly coincides with

the siphonal margin of the last volution, the presence of two lateral lobes is proved.

I have not been able to render the siphonal lobe entirely visible; for the rest the sutural line is perfectly identical with that in *P. Nala*. One auxiliary lobe and the commencement of an auxiliary saddle are outside the umbilical suture.

Locality and Geological position—number of specimens examined.—Otoceras beds. N. W. Kiunglung encamping ground, S.E. of Niti pass, 1, Coll. Griesbach; Shalshal cliff near Rimkin Paiar encamping ground, 1, Coll. Diener.

Suborder: PINACOCERATIDEA, Waagen.

Family: *PINACOCERATIDÆ*, Waagen.

Subfamily: MEDLICOTTINÆ, Karpinsky, emend. Waagen.

Genus: MEDLICOTTIA, Waagen.

1880. *Medlicottia*, Waagen: Salt Range Fossils, Palæontologia Indica, ser. xiii, I. Productus Limestone fossils, p. 83.
1887. *Medlicottia*, Gemellaro: La fauna dei calcari con fusulina della valle del fiume Sosio nella provincia di Palermo. Palermo, 1887, p. 50.
1889. *Medlicottia*, Karpinsky: Ueber die Ammoneen der Artinsk-Stufe und einige mit denselben verwandte carbonische formen. Mémoires de l'académie impér. des sciences de St. Pétersbourg, ser. vii, XXXVII, 1889, p. 21. For further references this most important memoir ought to be consulted.

Waagen, when introducing *Medlicottia*, considered the group of forms, designated by this new name as a mere section of the genus *Sageceras* (section of *Sageceras orbignyanum*, de Verneuil[1], distinguished by the peculiar development of its siphonal lobe. Its independent generic position has been advocated by A. Karpinsky, who in his beautifully illustrated memoir on the Cephalopoda of the Russian Artinsk stage thoroughly discussed its mode of development. He tries to prove that *Medlicottia* in its gradual development from the embryonic cell to the full grown individual passes at first through the same stages as *Pronorites*, but that, having attained the *Pronorites* stage (trifid siphonal lobe, bipartite principal lateral lobe, besides several simple lateral lobes), the progressive complication of the sutural line consists in a gradual augmentation of the number of the siphonal saddles and auxiliary lobes. In *Medlicottia* the development of adventitious elements takes its origin in the individualisation of the siphonal saddle, whereas in *Sageceras* it originates in the siphonal tubercle, according to the discoveries of E. v. Mojsisovics and Branco.

Karpinsky divides the genus *Medlicottia* into three sections, differing among each other by the peculiar shape of their siphonal parts. In the two groups of *M. orbignyana*, Vern., and of *M. artiensis*, Grüner, the siphonal area is distinguished by the presence of a median, longitudinal excavation between the marginal ridges,

[1] *Murchison, Verneuil et Keyserling.*—Géologie de la Russie d'Europe et des Montagnes de l'Oural, II. Paléontologie, Londres et Paris, 1845, p. 375, Pl. XXVI, fig. 6.

whereas in the group of *M. Wynnei*, Waagen, this longitudinal excavation is missing.

To this latter group belongs a new species from the Otoceras beds of the Shalshal cliff near Rimkin Paiar encamping ground. Its discovery is of special interest, as the presence of this form in deposits of a truly triassic age constitutes an important connecting link between the cephalopod faunæ of the palæozoic and mesozoic group in India.

The group of *M. Wynnei* seems to be exclusively restricted to the Indian triassic province. All the Russian and Sicilian representatives of the genus *Medlicottia*—with exception of *M. Schopeni*, Gem., one of the transitional forms between *Medlicottia* and the very closely related subgenus *Propinacoceras*, Gemellaro—are either allied to *M. artiensis* or to *M. orbignyana*. To this latter group also belongs an American species, *M. Copei*, White,[1] from the permo-carboniferous or permian Wichita beds of Baylor county in Texas.

1. Medlicottia Dalailamæ, nov. sp. Pl. I, fig. 6, Pl. VII, fig. 7.

Dimensions.

		Pl. I, fig. 6.
Diameter of the shell		79 mm.
" " " umbilicus		app. 12 "
Height of the last volution	from the umbilical suture	50 "
	" " preceding whorl	37 "
Thickness of the last volution		28 "
Breadth of the siphonal part		10·5 "

Medlicottia Dalailamæ, the first Himálayan *Medlicottia* discovered up to now, recalls, in its general shape and in the arrangement of its sutures *Medlicottia Wynnei*, Waagen (p. 81, Pl. VIII, fig. 2), whose nearest ally it certainly is.

Its whorls are somewhat thicker than in the Salt Range species. Their largest transverse diameter is situated within the lower third of their height. The lateral parts are rather convex, converging in a slight curve towards the siphonal part, but descending rapidly to the umbilical suture, without forming a distinct umbilical edge.

Although *M. Dalailamæ* is less compressed than *M. Wynnei*, its whorls increase more rapidly in height, as the overlap amounts to only a little more than one quarter of the height of the last volution. The deep umbilicus, within which the inner whorls are visible in the shape of narrow strips, is larger than in *M. Wynnei*.

The siphonal part is bordered by sharp marginal ridges, attaining a height of 1 mm., when fairly preserved. The siphonal area is broad and flat, and provided with a very low median keel, in the middle of which a delicate furrow is visible.

The cast of *M. Wynnei*, as described and figured by Waagen, is entirely smooth without any trace of sculpture. So is the cast of the Himálayan *M. Dalailamæ*. But the case is different, where parts of the shell are preserved, as in the specimen

[1] *C. A. White*,—Bull. U. S. Geol. Surv. No. 77. Washington, 1891. The Texan Permian and its mesozoic types of fossils, Pl. 1, fig. 1-3, p. 21.

figured Pl. I, fig. 6 a. They are covered by delicate striations, curved towards the siphonal margin in a slightly falciform shape, and grouped together in such a manner as to form very flat folds, with smooth intervals. The two striæ bordering each of these flat folds are always the most prominent ones. Towards the siphonal margin they disappear rather abruptly, whereas they are most strongly developed in the middle region of the lateral parts.

The two specimens are entirely chambered.

Sutures.—In its general characters the sutural line of this species is very similar to that of *M. Wynnei*. In both species five lateral lobes are present, in both the adventitious denticulations are arranged along the parallel margins of the siphonal saddles, their upper terminations showing in trefoil shape and in none of them is the difference between larger and smaller lateral lobes very conspicuous.

The narrow siphonal lobe ends in a sharp point on both sides of the semicircular siphonal tubercle. The high siphonal saddle is bordered by parallel margins and exhibits six indentations or small adventitious lobes along its outer, and seven along its inner, boundary. The indentations near the upper termination of this saddle are as strong as the rest. They correspond to each other in a perfectly symmetrical manner, with the exception of the lowest adventitious indentation at the base of the inner margin, which is bipartite.

As in *M. Wynnei* this siphonal saddle is situated precisely on the marginal edge of the whorl, so as to be placed with one side on the flat siphonal part, with the other on the lateral part of the shell, the marginal ridge cutting it into two symmetrical portions.

The base of the siphonal lobe is situated considerably higher than the lateral lobes. It is at an equal height with the middle of the first lateral saddle, whereas in *M. Wynnei* it is on the same level with the second lateral lobe.

The principal and third lateral lobes are the largest. Of their two unequal branches the minor ones are the longer. The second lateral lobe is much shorter and of nearly equal size with the fourth lateral lobe. From the third lateral lobe and towards the umbilical suture the lobes gradually diminish in size. There is no remarkable difference in size between the three first lateral lobes and the following ones, as in *Medlicottia artiensis.*[1]

The projection of the periphery of the penultimate whorl touches the outer branch of the fifth lateral lobe in the last volution. The auxiliary lobes follow to the number of four outside the umbilical suture. The two first are bipartite like the lateral lobes, but with symmetrically arranged branches. The following auxiliary lobes are simple, their terminal branches disappearing gradually.

Locality and Geological position—Number of specimens examined.—From the main layer of the Otoceras beds, Shalshal cliff near Rimkin Paiar encamping ground; 1, Coll. Diener; from the shales immediately above the main layer of *Otoceras woodwardi*, Griesb. 1, Coll. Diener.

Remarks.—*Medlicottia Dalailamæ* is most probably a descendant of *M.*

[1] *A. Karpinsky,*—Mém. de l' acad. imp. des sciences de St. Pétersberg, ser. vii, XXXVII, 1889, Pl. I, fig. 1, p. 36.

Wynnei, Waagen, to which form it is closely allied. There are, it is true, sufficient differences between the two forms to make their distinction rather easy. In the Himálayan species the transverse section is considerably broader, the umbilicus is larger, and the margins of the siphonal part are provided with sharp ridges. Its sutural line differs by a shorter siphonal lobe, by the bipartite arrangement of the lowest adventitious indentation at the interior margin of the siphonal saddle, and in the larger size of the interior branch at the base of the principal lateral saddle.

These points of difference are, however, of small importance compared with the close affinity to *M. Wynnei* which this species exhibits in its most conspicuous characters, and there can be no doubt that the two species belong to one and the same group of forms. In addition to Karpinsky's classification of the species which belong to the genus *Medlicottia*, the hitherto known forms of the latter may be grouped most conveniently as follows:—

Group of Medlicottia orbignyana, Vern.

1. *M. orbignyana*, Vern.	Ural, Sicily.
2. *M. primas*, Waagen	Salt Range.
3. *M. Verneuili*, Gemellaro	Sicily.
4. *M. Marcoui*, Gem.	Sicily.
5. *M. difrons*, Gem.	Sicily.
6. *M. Copei*, White	Texas, U. S.

Group of Medlicottia Wynnei, Waagen.

1. (7) *M. Wynnei*, Waag.	Salt Range.
2. (8) *M. Dalailamæ*, nov. sp.	Himálayas.

Group of Medlicottia artiensis, Grün.

1. (9) *M. artiensis* Grünewaldt	Ural.
2. (10) *M. sp. ind.*, Karpinsky	Ural.
3. (11) *M. karpinskyana*, Kortow	Ural.

Group of Medlicottia Schopeni, Gem.

1. (12) *M. Schopeni*, Gemellaro	Sicily.

The presence of *Medlicottia Dalailamæ* in the Otoceras beds of Pain Khánda is of great interest, as it appears to be the only species of *Medlicottia* which has as yet been found in triassic beds, if we except an unpublished form from the Meekoceras beds of Idaho (U.S. North America), which, according to White's opinion, will turn out to belong either to this genus or to *Sageceras*.[1]

Subfamily: HEDENSTROEMINÆ, Waagen.

Genus: HEDENSTROEMIA, Waagen.

The genus *Hedenstroemia* is looked upon by Waagen as type of a subfamily of the *Pinacoceratidae* in which, besides this genus *Clypites*, Waagen, and *Carnites*

[1] *C. A. White*, The Texan Permian and its mesozoic types of fossils, Bull. U. S. Geol. Surv., No. 77, Washington, 1891, p. 21.

v. Mojsisovics are included.[1] According to his view these three genera are characterised by a shell which is generally very similar to that of the *Meekoceratinæ*, with two edges along the siphonal part, and by the existence of only a single adventitious lobe, which perhaps is only developed in later stages of growth.

The two typical species of the genus *Hedenstroemia* are *H. Hedenstroemi*, Keys. and *H. furcata*, Mojs. The first species is based on a specimen, collected by Hedenström at Kotelny, one of the New-Siberian islands, which was first described by Eichwald in the Bull. Scient. de l' Academie des sciences de St. Petersbourg, IX, p. 113, in 1892. It was described and figured as *Ceratites Hedenstroemi* later on by Graf A. v. Keyserling in the report on A. Th. von Middendorff's journey, together with specimen of a true *Meekoceras* which this celebrated traveller had acquired at Jakutsk among a collection of other triassic and jurassic fossils from the mouths of the Olenek River.[2] E. v. Mojsisovics[3] in his Memoir on the triassic faunæ of the Arctic region, transferred the species, together with a second one, *H. furcata*, Oeberg, which had been collected in the Posidonomya limestone of Spitzbergen and described by Oeberg in 1877, to the genus *Meekoceras*, in spite of its decidedly marked adventitious lobe. Another species very closely allied to *H. Hedenstroemi* was described by the same author in 1888 from the collection of Dr. Hubendorff, made in 1859 in eastern Siberia.[4] The latter species E. v. Mojsisovics compares to *Proptychites lawrencianus*, de Kon., on account of the similar shape of their saddles in the sutural line. The presence of adventitious elements he apparently did not think to be of generic importance, probably from an analogy to the development of the sutural line in *Carnites*, Mojs.[5]

Like the above mentioned species of *Hedenstroemia*, *Carnites* is distinguished by the presence of adventitious elements in the full grown stage. In quite young specimens only, which in their general shape have not yet passed from the *Meekoceras* stage into the *Hungarites* stage, the sutural line is simple and no distinct adventitious lobe is visible.

While E. v. Mojsisovics considers the adventitious lobe in *Carnites* (and consequently also in *Hedenstroemia*) as a character of minor importance, which is acquired in later stages of growth only, Waagen in his memoir on the triassic Cephalopoda of the Ceratite formation in the Salt Range takes a perfectly different view of the subject. He thinks that the formation of a separate adventitious lobe requires such a peculiar mode of development of the sutural line, that the presence or absence of adventitious elements, in forms which are really intimately connected,

[1] *Waagen*,—Ceratite formation, *loc. cit.*, p. 141.

[2] A. Th. von Middendorff's Sibirische Reise, I. pt. 1. p. 277; and Bull. phys. math. de l' acad. des Sciences de St. Pétersbourg, V. No. 11, p. 166. Pl. II., fig. 5, 6, 7.

[3] Arktische Triasfaunen, *loc. cit.*, p. 80, 81

[4] *E. v. Mojsisovics*, Ueber einige arktische Trias Ammoniten des nördlichen Sibiriens, Mém. de l' Acad. impér. des Sciences de St. Pétersbourg, ser. vii, XXXVI, No. 5, 1888, p. 10, Pl. II, fig. 13.

[5] *E. v. Mojsisovics*,—Cephalopoden der Mediterranen Triasprovinz, Abhandlgn. k. k. geol. Reichs—Anstalt Wien, X, p. 227.

as different species of one and the same genus are supposed to be, must needs be a character of the highest importance. Waagen consequently includes all the forms, provided with a laterally compressed shell and distinctly separated adventitious elements in their sutural line, in the family *Pinacoceratidæ*. He therefore removed *Hedenstroemia Hedenstroemi*, the Olenek species closely allied to the former, which had been described by E. v. Mojsisovics, and also *H. furcata*, from the genus *Meekoceras*, and united them in his new genus, taking the name from the discoverer of the first triassic ammonite in Siberia.

I am bound to confess, that I fully agree with Waagen's opinion regarding this subject, and I may add that it is especially Karpinsky's[1] interesting study on the development of the sutural line in *Medlicottia*, which induces me to do so. As far as the *Pronorites* stage, the development of the sutural line in *Medlicottia* has been followed in a really convincing manner. But neither in this stage nor in the following *Sicanites* stage—bipartite lateral lobes and bipartite siphonal saddle—adventitious elements are present. From this fact we may conclude, that the ancestors of *Medlicottia* like those of *Carnites* were not provided with adventitious elements, and that even in *Medlicottia*, which is decidedly one of the most typical members of the *Pinacoceratidæ*, adventitious lobes do not exist in the juvenile state, but, as in *Carnites*, are only acquired in later stages of growth.

E. v. Mojsisovics has been misled, in his comparison to *Proptychites lawrencianus*, de Kon.,[2] by M. de Koninck's drawing, in which the siphonal prominence may be easily mistaken for an adventitious saddle. In reality the similarity of *Hedenstroemia* and the Salt Range species is only a very distant one.

Quite recently E. Haug[3] also removed *Hedenstroemia furcata*, Oeberg, from the genus *Meekoceras*, into which it had been placed by E. v. Mojsisovics, but united it with *Norites*, v. Mojs.,[4] which has no adventitious lobe. This view is, however, decidedly erroneous. Either Haug confused the characteristic indentation in the principal lateral lobe of *Norites* with an adventitious saddle, or he considered the two marginal edges of the siphonal part to be of generic importance, whereas they are of a very subordinate systematic value, as pointed out by E. v. Mojsisovics and Waagen, and fully confirmed by my studies of the Himálayan species of *Danubites, Flemingites, Meekoceras* and *Ophiceras*.

In the subrobustus beds of the Himálayan lower trias, *Hedenstroemia* is represented by two species, one of which is identical with the Siberian form described by E. v. Mojsisovics. In the Salt Range the present genus is replaced by *Clypites*, Waagen, which in its general shape is somewhat similar to *Hedenstroemia*, but differs from the latter by a much less distinctly individualised adventitious lobe.

[1] *A. Karpinsky*, Ueber die Ammoneen der Artinskstufe und einige mit denselben verwandte carbonische Formen Mém. de l'acad. imp. des sciences de St. Pétersbourg, vii. ser, XXXVII, 1889. p. 22, 23.

[2] *L. de Koninck*, Descriptions of some fossils from India, discovered by Dr. A. Fleming of Edinburgh, Quart. Journ. Geol. Soc. XIX. 1863, pl. VI. fig. 3.

[3] *E. Haug*, Les ammonites du Permien et du Trias. Remarques sur leur classification, Bull. Soc. Géol. de France iii. ser, XXII. 1894. p. 393.

[4] *E. v. Mojsisovics*, Cephalopoden der Mediterranen Triasprovinz, l. c. p. 201.

1.—Hedenstroemia Mojsisovicsi, Diener, Pl. XX, fig. 1 a, b, c.

1888. *Meekoceras nov. sp. ind. ex. aff. M. Hedenstroemi*, E. v. Mojsisovics, Ueber einige arktische Trias-Ammoniten des nördlichen Sibirien, Mém. de l'acad. impér, des sciences de St. Pétersbourg, sér. vii, XXXVI, No. 5, p. 10, Pl. II., III, fig. 13.

Dimensions.

Diameter of the shell	174	mm.
" " " umbilicus	13	"
Height of the last volution { from the umbilical suture	96·5	"
Height of the last volution { " " preceding whorl	55	"
Thickness of the last volution	42	"

One of the species from the subrobustus beds of Spiti in Griesbach's collection is identical with the fragment, figured and described by E. v. Mojsisovics and considered by this author as a near ally to *Hedentroemia Hedenstroemi*, Keyserling. As my specimen is much more complete than Stubendorff's Siberian fragment, I have ventured to give a proper name to the species, whose characters can now be fixed in a more satisfactory manner.

The general shape of the shell is flatly disciform, with high whorls, a comparatively small umbilicus and a flattened siphonal part, bordered on both sides by distinct marginal edges. Although the surface of my specimen is much weather worn and the marginal edges have consequently been rendered obtuse or rounded off along the greater portion of the periphery, their originally sharp condition is still partly shown.

The transverse section of the whorls is sagittate. The largest transverse diameter corresponds to the lower part of the volutions. The lateral parts are flatly arched. A rounded off umbilical edge separates them from the low but vertical umbilical wall.

The overlap of the last volution over the previous one amounts to but little less than half of the height of the former. The volutions are more than twice as high as broad.

In this specimen exactly one quarter of the last volution forms part of the body chamber.

Sutures.—The most characteristic part of this species is its sutural line.

The siphonal lobe is rather short and divided by a very high siphonal prominence, which reaches almost to the same level as the adventitious saddle. Each of the two branches of the siphonal lobe is provided with a very strong indentation, which is situated about near the middle of the height of the siphonal prominence. By this indentation, which almost takes the shape of a proper adventitious element each of the two lateral branches of the siphonal saddle is divided into two portions. They terminate both in single, sharp points, but the one situated nearer to the siphonal prominence is considerably shorter.

The siphonal lobe is followed by a narrow, elongated adventitious saddle, which is rounded above and considerably lower than the second adventitious saddle. The adventitious lobe, situated between the two adventitious saddles, is considerably longer than the lateral branches of the siphonal lobe. It terminates with two denti-

culations at its base, which are accompanied by two smaller denticulations, situated a little higher up, at the base of the marginal walls. The second adventitious saddle is elongated, symmetrical and narrow, rounded above to the shape of a pointed arch, as in *Proptychites lawrencianus*, de Kon., or in *Aspidites superbus*, Waag.[1]

The principal lateral lobe is the largest, and is provided with eight to ten denticulations, which do not affect the marginal walls of the adjoining saddles.

The principal lateral saddle is the highest among all. It is very obliquely rounded above, its highest point being shifted towards the umbilical region. As in the second adventitious saddle, its top forms an entire, rounded, and somewhat pointed arch. It slopes rather steeply towards the broad second lateral lobe, which is provided with six to seven coarse indentations.

The broad second lateral saddle is not pointed above, but of a rather clumsy shape and very broadly rounded. The projection of the periphery of the preceding whorl divides it in two. The auxiliary series consequently begins at the umbilical side of this saddle.

The broad, first auxiliary lobe exhibits a tripartite arrangement, and is distinctly individualised. A row of irregular indentations follows which is characterised by a remarkable difference in the shape of the denticulations corresponding to lobes and saddles. The former are sharply pointed, the latter obtusely rounded above and bordered by marginal walls, which converge decidedly towards the tops.

As far as the umbilical suture the auxiliary series may be resolved into three lobes and four saddles. The first two saddles culminate in two obtusely rounded denticulations. The serrations between these secondary denticulations are shorter and narrower than the one which separates the two saddles themselves. This latter indentation—the second one counting from the first auxiliary lobe towards the umbilical suture—ought therefore to be considered as the second auxiliary lobe. The third auxiliary lobe is again more distinctly marked than the indentation separating the two culminating points of the second auxiliary saddle. The two following auxiliary saddles are not bipartite. The fourth auxiliary saddle is very flat and extends along the low umbilical wall below the umbilical suture.

The internal lobes are not completely preserved, as is the case in Stubendorff's fragment from the Olenek beds. It is possible, however, to state the remarkable length of the funnel lobe (as the antisiphonal lobe or internal lobe has been called by Hyatt).

If we compare the sutural line of our specimen with that of the fragment, figured and described by E. v. Mojsisovics, we find a most striking similarity even in the minor details. In the Siberian fragment the siphonal and adventitious lobes with the intervening saddle are partly weather worn and their details destroyed. The identity of the general arrangement of the adventitious elements in the two specimens is, however, clearly proved by the figure (loc. cit., Pl. III, fig. 13). From the second adventitious saddle as far as the first auxiliary saddle the lobe line is perfectly identical. The auxiliary series is asymmetrically developed on the two sides

[1] Ceratite formation, Pl. XXIII, XXIV, fig. 1 a, b, p. 218.

of the Siberian fragment. The left side is identical with our specimen, whereas on the right side the following differences may be observed. The first auxiliary saddle is tripartite instead of culminating in two denticulations only, and the third auxiliary lobe is less distinctly individualised.

As perfect identity of the left side of the Siberian specimen and ours exists regarding the very characteristic and complicated sutural line, and as the two specimens equally well agree in all the other characters, as far as they can be made out from v. Mojsisovics' fragment, I think to be justified in uniting them as one and the same species, which will bear the name of the celebrated Viennese palæontologist.

Locality and Geological position. Numbers of specimens examined.—Sub-robustus beds, S.E. of Muth, Spiti, 1, Coll. Griesbach.

Remarks.—The nearest ally to this species is *Hedenstroemia Hedenstroemi*, Keyserling.[1]

As has been pointed out by E. v. Mojsisovics (Arktische Triasfaunen, p. 81), the name *H. Hedenstroemi* must be kept for the specimen mentioned by Eichwald in 1842, with which the specimen of a true *Meekoceras* (subgenus *Kingites*, Waagen) without any adventitious lobes, from the Olenek beds, have been erroneously identified by Graf. Keyserling (loc. cit., Pl. III, fig. 1, 2, 3). If the name *H. Hedenstroemi* is restricted to the fragment from the island Kotelny, as it ought to be done, a comparison of this species with ours leads to the following conclusions.

In general shape and involution the two species are very similar. It is very doubtful whether Keyserling's figure (Pl. II, fig. 7) is correct as regards the sharp edged character of the siphonal part, as the impression of the broken off inner volution at the internal part of the fragment clearly shows the presence of two marginal ridges along the siphonal part of the penultimate whorl.

As regards the arrangement of the sutural line, the chief difference consists in the extremely short siphonal lobe of the Siberian fragment. The first adventitious saddle is therefore much higher towards the adventitious lobe. The three following lobes and saddles agree tolerably well in the two species. Of the auxiliary series nothing is preserved in the fragment collected by Captain Hedenström. In Keyserling's figure this part of the sutural line has been reconstructed from one of Middendorff's fragments, which accidentally seemed to correspond to the former. It has, however, been demonstrated by E. v. Mojsisovics that this combination rests on very unsafe ground, and that the actual arrangement of the auxiliary series in *H. Hedenstroemi* is still an open question.

2. Hedenstroemia sp. ind. ex aff. H. Mojsisovicsi, Dien, Pl., XXII, fig. 2.

Dimensions.

Diameter of the shell	app. 105	mm.
" " umbilicus	11·5	"
Height of the last volution	57	"
Thickness of the last volution	20	"

[1] *Graf. Keyserling*, Beschreibung einiger von Dr. A. Th. Middendorff mitgebrachten Ceratiten des arktischen Sibiriens. Bull de l'Académie des Sciences des St. Petersbourg, V No. 11 p. 7, Pl. II, fig. 5, 6, 7, reproduced in A. Th. v. Middendorff's "Sibirische Reise," Bd. I, Th. i, Taf, II, fig. 5, 6, 7, p. 244.

These measurements refer to a rather fragmentary specimen in Griesbach's collection.

It is very similar to the preceding species in general shape, differing specifically by the arrangement of its auxiliary series of the sutural line. As in *Hedenstroemia Mojsisovicsi* the transverse section of the volutions is more than twice as high as broad, of a sagittate shape, bordered by flatly arched lateral parts and provided with marginal ridges which separate the former from the narrow and perfectly flat siphonal part. A low but vertical umbilical wall surrounds the small umbilicus. It joins the lateral parts in an obtusely rounded umbilical edge.

The surface of the cast is smooth, no trace of any sculpture being indicated either in this or in the preceding species.

The fragment consists of air chambers only.

Sutures.—The first adventitious saddle is considerably smaller than in *H. Mojsisovicsi*, whereas the adventitious lobe is only a little shorter than the principal lateral lobe. It is not distinctly bipartite at its base as in the preceding species, but terminates in a single sharp point, the other denticulations forming together a distinct arch. The siphonal lobe is not well enough preserved to allow of its being studied in detail. The two lateral lobes and saddles are identical with those in *H. Mojsisovicsi*, and I need not therefore describe them further.

Essential differences exist however in the arrangement of the auxiliary series. The first auxiliary lobe is followed by a clumsy saddle of nearly equal shape and but little less size than the second lateral saddle. Its inner (umbilical) margin is again bordered by a strongly serrated, distinct auxiliary lobe. That the first auxiliary lobe and saddle really hold this position and not, as one might be induced to suppose from their shape, that of a third lateral lobe and saddle, I have been able to determine by breaking the specimen in two. The projection of the periphery of the penultimate volution touches the top of the second lateral saddle. The following lobe and saddle must consequently be considered as belonging to the auxiliary series in spite of their shape and size.

It may be questioned, whether the next sutural element ought more properly to be considered as a bipartite auxiliary saddle or as two independent saddles divided by a short auxiliary lobe. The next rounded auxiliary lobe is again perfectly distinct. It is followed by a flat auxiliary saddle, reaching down to the umbilical suture. The two culminations of the doubtful bipartite auxiliary saddle are conical, with rounded tops. They are separated by a sharply pointed indentation.

Locality and Geological position. Number of specimens examined.—Subrobustus beds S. E. of Muth, Spiti, 1, Coll. Griesbach.

Family: *PTYCHITIDÆ* mihi (*Ptychitinæ*. v. Mojs.).

a. Subfamily: NANNITINAE, Diener.

Genus: NANNITES, v. Mojsisovics.

The genus *Nannites* was introduced by E. v. Mojsisovics[1] for a few upper triassic

[1] *E. v. Mojsisovics*,—Die Cephalopoden der Mediterranen Triasprovinz, Abhandl'g. k. k. Geol. Reichs-Anst., 1882, X, p. 210.

species, from the Alpine Wengen and St. Cassian beds, distinguished by their very globose shape and a most simple goniatitic lobe line.

In the diagnosis of this genus the following characters are quoted by E. v. Mojsisovics as of generic importance. Shell smooth or provided with contractions, volutions globose, overlapping each other to a very remarkable extent, body chamber short, occupying three quarters of the last volution. The perfectly goniatitic sutural line reminds one of palæozoic *leiostraca* and consists of a deep siphonal lobe, divided by a siphonal prominence, a rounded lateral lobe, which corresponds to the projection of the periphery of the preceding volution, and a short rounded off auxiliary lobe.

The presence of this genus in strata of upper triassic age seemed to be so much the more strange, as none of its representatives had been met with hitherto in older deposits. Now, the presence of two species of *Nannites* in the Otoceras beds of Spiti is demonstrated. They fully agree in all their principal characters with the diagnosis given by v. Mojsisovics and there can be no doubt as to their belonging to this genus.

Whereas in this manner the existence of *Nannites* in the Himálayan lower trias is proved, its occurrence in the Muschelkalk is as yet doubtful. In Stoliczka's collection from Spiti, there is, it is true, a fragmentary specimen of a globose ammonite with apparently goniatitic sutures, which on account of its bad state of preservation, I did not venture to describe in my memoir on the Cephalopoda of the Himálayan Muschelkalk. Now, however, since I have been able to prove the presence of *Nannites* in the Himálayan lower trias, I am much inclined to refer this fragment to the same genus.

It has been remarked by E. v. Mojsisovics, that it might perhaps be more convenient, to consider *Nannites* as the type of a proper subfamily. The "family" *Pinacoceratidæ*, v. Mojsisovics, has since been promoted by Waagen to the rank of a suborder, and its different subfamilies have been broken up into a number of subdivisions. I am consequently obliged to establish the subfamily *Nannitinæ*, in which the genus *Nannites* will have to be comprised.

I must say a few words here about the classification of the different subdivisions of the *Ptychitidæ*, adopted in the present memoir.

In accordance with K. A. von Zittel[1] I accept the *Ptychitidæ* in the extension given to the subfamily *Ptychitinae* by E. v. Mojsisovics, but as a proper family. Among this family I am going to distinguish the *Nannitinæ*, *Ptyichitinæ* (=*Ptychitidæ*, Waagen), *Hungaritinæ* and *Meekoceratinæ*, (=*Meekoceratidæ*, Waagen) as subfamilies. In this respect I am, it is true, at variance with Waagen, who does not accept the *Ptychitinæ* in the sense of E. v. Mojsisovics as a proper family, but distinguishes among the *Pinacoceratidæ* occurring in the Salt Range the five families *Lytoceratidæ*, *Pinacoceratidæ*, *Ponitidæ*, *Ptychitidæ* *Meekoceratidæ*. Were I to accept this classification for the Himálayan Cephalopoda, I ought to have added two more families to those mentioned by Waagen, *viz.*, the *Nannitidæ* and the *Hungaritidæ*. But this did not seem to fit into the classification of the *Ammonea*

[1] *K. A. von Zittel*, Handbuch der Palæontologie, I Abthg. II. Bd., p. 446.

trachyostraca, in which two families only of a much larger extent are generally understood in which the different types, united into subfamilies, deviate at least as far from each other as the *Meekoceratinæ* do from the *Ptychitinæ* or from the *Hungaritinæ*.

After these general remarks I may proceed now with specific descriptions.

1. Nannites hindostanus, nov. sp. Pl. VII, fig. 3, 11, 12.

Dimensions.

		Fig. 3.
Diameter of the shell		17 mm.
" " " umbilicus		4 "
Height of the last volution	from the umbilical suture	7·5 "
	" " preceding whorl	4·5 "
Thickness of the last volution		8 "

In the Himálayan collection there are several specimens which belong to this species, and several amongst them with their entire body chambers and the apertural margins preserved.

In general shape and involution the species reminds one of *N. spurius*, Munster,[1] from St. Cassian, whereas in the two other Alpine species of this genus, *N. Bittneri*, Mojs.,[2] and *N. fugax*, Mojs.,[3] the whorls overlap each other to a somewhat larger extent.

The shell is thickly globose with inflate volutions, as in the family of the *Arcestidæ* or in young individuals of *Ptychites*. The whorls do not overlap each other completely and consequently leave a comparatively wide umbilicus open. The transverse section is thicker than high, even in full grown specimens. Its largest transverse diameter is situated in the neighbourhood of the umbilical region.

The siphonal part is broadly rounded and passes gradually into the lateral parts, which in their lower portion are running almost parallel and join the vertical umbilical wall in a distinct umbilical edge.

The surface of the cast is covered by distinctly marked contractions, to the number of about 16 in the last volution of my largest specimen (Pl. VII, fig. 3). These contractions reach from the umbilical suture in the shape of strongly forward bent curves across the siphonal side, where they are more deeply sunk, than in the lateral parts. The laminæ of the shell, being situated behind these contractions, are sharply cut off by the latter; whereas they gradually pass into the laminæ situated in front. This phenomenon has been called "direct imbrication" by E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, p. 12).

In one of my specimens the shell is partly preserved (Pl. VII, fig. 11). It is covered with very numerous and delicate striations, parallel to the contractions. These striations which correspond to the lines of growth of the shell, as well as the contractions themselves, are an exact copy of the shape of the apertural margin, which in some of my specimens is perfectly well marked. From the sutural line to the

[1] *Graf Zu. Munster.*—Beitrage zur Geognosie und Petrefactenkunde des südöstlichen Tirols, p. 127, Pl. XIV, fig. 7.
[2] *E. v. Mojsisovics*, Cephalopoden der Mediterranen Triasprovinz, p. 210, Pl. XXXIX, fig. 11.
[3] *E. v. Mojsisovics* ibid. p. 211, Pl. XXXIX, fig 10

siphonal part it describes a falciform, strongly forward bent curve with a slight depression near the siphonal margin.

From the specimen figured Pl. VII, fig. 11, it may be clearly seen that the contractions are restricted exclusively to the cast, but are absent in the shell. The cast of the inner volutions of this specimen shows the contractions distinctly, whereas but very faint traces of them are visible in the last volution in places where the shelly layer has been preserved. From this fact it is evident, that the contractions correspond to thickened portions in the interior of the shell as in the genus *Arcestes*.

Exactly three quarters of the last volution belong to the body chamber.

Sutures.—The general similarity in the arrangement of the sutural line in *Nannites* to *Tirolites* and *Dinarites* has been pointed out by E. v. Mojsisovics, who found however a point of difference in the fact, that in the two genera of the *Ammonea trachyostraca* the projection of the periphery of the penultimate whorl touches the lateral saddle of the last volution, whilst in *Nannites* it touches the lateral lobe. Our species is provided with a sutural line, the arrangement of which is in full accordance with the one observed in typical species of *Dinarites* or *Tirolites*, as the lateral saddle, not the lobe, is met by the projection of the periphery of the preceding whorl.

The sutures are perfectly goniatitic. The lobes are of nearly equal depth. The auxiliary lobe is situated a little lower than the lateral lobe, which in itself stands at a somewhat lower position, than the siphonal lobe. Our species is therefore easily distinguished from *N. spurius*, which is characterised by a very deep position of its siphonal lobe. The siphonal lobe is divided into two terminal branches by a very short and broad siphonal prominence. The siphonal saddle is the largest. The saddles are converging upwards, but evenly rounded above. The flat auxiliary lobe is distinctly marked outside the umbilical suture.

Two internal lobes occur on each side of the antisiphonal lobe.

Locality and Geological Position—Number of specimens examined.—Otoceras beds; S.E. of Muth, Spiti, 12, Coll., Griesbach. The specimens were extracted from a dark, semicrystalline limestone together with the following species and with *Flemingites Guyerdeti.*

2. Nannites Herberti, nov. sp. Pl. VII, fig. 2.

Dimensions.

Diameter of the shell		14 mm.
" " " umbilicus		4 "
Height of the last volution	from the umbilical suture	6 "
	" " preceding whorl	3 "
Thickness of the last volution		7·5

This species is distinguished from the preceding one by a more considerable overlap of the volutions, recalling in this respect *N. Bittneri*, v. Mojsisovics, and by a smaller number of deep contractions. As in the preceding species the contractions are directly imbricated. In the last volution of my specimen five contractions may be counted.

The volutions are thicker than high. The overlap of the last over the penultimate whorl is at least one half of the entire height of the former. In this respect the figure Pl. VII, fig. 3 b, is incorrect, as may be easily seen from a comparison with fig. 3 a.

Between the contractions of the cast, the most important elements of its sculpture, delicate furrows occur, which are especially well marked in the siphonal part. No trace of the shell is preserved.

The greater portion of the last volution in the specimen described belongs to the body chamber, but the apertural margin is not preserved. Of the sutures faint traces only are indicated, and it is sufficient to state that they are in general identical with those of *Nannites hindostanus*. An auxiliary lobe is present. The projection of the periphery of the penultimate volution apparently meets the lateral lobe in the last whorl.

Locality and Geological position—Number of specimens examined.—Otoceras beds; S.E. of Muth, Spiti, 1, Coll. Griesbach.

b. Subfamily: PTYCHITINÆ mihi (=*Ptychitidæ*, Waagen).

PROPTYCHITINÆ, Waagen.

Genus: PROPTYCHITES, Waagen.

1892. *Proptychites*, Waagen: Rec. Geol. Surv. Ind. XXV, 193.
1892. *Proptychites*, Waagen: Jahrbuch k. k. Geol. Reichs-Anst., XLII. 379.
1895. *Proptychites*, Waagen: Salt Range Fossils, Palæontologia Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 162.

The genus *Proptychites* has been created by Waagen for the accommodation of *Ceratites lawrencianus*, de Kon,[1] and a great number of closely allied forms from the Ceratite Formation of the Salt Range. Griesbach[2] in his memoir on the Cephalopoda of the Himálayan Otoceras beds had united de Koninck's species with the genus *Ptychites*, on account of a general similarity in the shape of the shell and the mode of involution. Later on it was placed into the genus *Meekoceras* by E. v. Mojsisovics,[3] who even supposed from de Koninck's figure, that it might belong to his group of *Meekoceras Hedenstroemi*, distinguished by the presence of an adventitious lobe.[4] This suggestion has been proved to be erroneous by Waagen, who in his views, regarding the generic position of *Ceratites lawrencianus*, comes much nearer to Griesbach's opinion. He not only removes the species from *Meekoceras* but from the *Meekoceratidæ* altogether and considers it as type of a proper genus, which together with *Ptychites*, v. Mojs., *Sturia*, v. Mojs., and Waagen's new genus *Beyrichites* form part of a subfamily of his *Ptychitidæ*.

[1] Quart. Journ. Geol. Soc., XIX, p. 14, Pl. VI, fig. 3, and "Mémoire sur les fossiles paléozoiques, recueillis dans l' Inde" p. 8.

[2] Palæontological notes on the Lower Trias of the Himálayas, Rec. Geol. Surv. Ind., XIII, p. 109.

[3] Arktische Triasfaunen, p. 79.

[4] *E. v. Mojsisovics*,—Ueber einige arktische Trias ammoniten des nördlichen Sibirien. Mém. de l' acad. imp. des sciences de St.Pétersbourg, ser. vii, XXXVI, No 5, p. 10.

Proptychites is considered by Waagen to be the presumptive ancestor of *Ptychites*. He lays a special stress on the striking similarity, which most of the Salt Range species belonging to this genus bear to the group of the *Ptychites flexuosi*, not only in the general configuration of the shell, finding its expression chiefly in the similar transverse section of the whorls, but also in the sculpture, as far as any such exists. There remains, however, a remarkable difference in the sutural line, which in *Proptychites* is either ceratitic or in the most developed species (*Proptychites ammonoides*, Waagen, loc. cit. Pl. XVII, fig. 1, Pl. XIX, fig. 2, p. 171) brachyphyllic, but never phylloid, as in *Ptychites*. Although it is true, that the siphonal tubercle in most species of *Proptychites* is of an unusually large size, the siphonal saddle never takes the characteristic shape of a very subordinate sutural element as in typical species of *Ptychites*. As has been pointed out by Waagen himself transitional species between the two genera have not been found up to the present, and in the species hitherto known the difference in the general arrangement of the sutural line is still so considerable, that a close affinity between *Proptychites* and *Ptychites* is yet far from being established.

The question, whether *Proptychites*, which after all is distinguished both from *Ptychites* and from *Meekoceras* by sufficiently well marked generic characters, ought to be placed among the *Ptychitinæ* or the *Meekoceratinæ* can, however, be decided from another point of view. The typical species of *Meekoceras* are distinguished by comparatively high and compressed whorls, even in young stages of growth, although, as in most triassic ammonites, they are more compressed when full grown. In *Ptychites*, on the contrary, one of the most important characters is the globose shape in young stages, recalling *Arcestes*. In the groups of the *rugiferi* and of the *opulenti*, the thick, globose original shape persists even in the full grown individual, whereas in the groups of the *megalodisci*, *flexuosi* and *subflexuosi* the shape of the individual changes considerably in different stages of growth. To all these groups, however, the original globose shape of the interior volutions is common. In this respect many instances have been described by E. v. Mojsisovics in his Cephalopoden der mediterranen Triasprovinz. Among the Himálayan species of *Ptychites* the one, described as *Ptychites Sahadeva* in my memoir on the Cephalopoda of the Himálayan Muschelkalk (Pl. XXV, fig. 1, 2) gives a good illustration of this feature. Whereas in the full grown specimen (fig. 1) the volutions are considerably higher than broad, the reverse is the case in the smaller specimen (fig. 2).

When describing the Cephalopoda of the lower trias from the Ussuri district (Eastern Siberia), collected by Swanow, I had an opportunity of examining a great number of typical *Proptychites*, which genus is very largely represented in the fauna of these beds. From the cross section of *Proptychites hiemalis*. Dien., full evidence of the globose shape of the young individuals could be got. In my larger specimens a transverse diameter of 21, *viz.*, 17 mm., corresponded to a height of the volution of 33, *viz.*, 28 mm. The volutions of the full grown specimens therefore appeared to be scarcely less compressed than in some species of the *Meekoceratinæ*, for instance *Koninckites lyellianus*, de Kon., or in *Koninckites gigas*, Waagen (loc. cit. Pl. XXXI,

fig. 26). But in the penultimate volution of another specimen the proportion of height and thickness was as 13 to 12, and in a specimen, figured in the Mémoires du Comité Géologique de la Russie, XIV, No. 3, Pl. V, fig. 4, it was as 10·5 to 10 only.

As the results of Waagen's important studies were not yet known to me at the time when I wrote my memoir on the Cephalopoda of the Himálayan Muschelkalk, I had accepted the genus *Meekoceras* in the same, rather wide sense, in which the name had been applied by E. v. Mojsisovics. Waagen since tried to prove that three different groups of forms had been mixed up by E. v. Mojsisovics in the genus *Meekoceras*. Only one of them, with *Meekoceras caprilense* as prototype, ought to remain in this genus, whilst the others should be placed among the *Proptychitinæ*. *Meekoceras cadoricum*, v. Mojs., is considered by Waagen to belong most probably to *Proptychites*. *Meekoceras reuttense*, Beyr., *M. Khanikofi*, Oppel, and *M. proximum*, Oppel, with their allies are united by the same author into a separate genus, for which the name *Beyrichites* is proposed. This new genus Waagen thinks to be intimately connected with *Proptychites* and consequently places it into the same subfamily.

The genus *Meekoceras*, as accepted by E. v. Mojsisovics and by myself, having thus been separated by Waagen into three widely different groups, a complete revision of the Himálayan forms, which I had originally united under this name, became unavoidable.

Since only the mode of development in the different species could afford a decisive clue as to their relationship to the *Ptychitinæ* or *Meekoceratinæ*, I carefully studied the transverse sections of nearly all my specimens. The excellent state of preservation of my Himálayan material permits a positive decision on this matter. It gives full evidence, that there are really two series present among the forms of the Himálayan Muschelkalk, united hitherto in the genus *Meekoceras*, which are distinguished by a quite different development. In one of these two developmental series the compressed whorls persist even in quite young stages, whereas in the other series the original shape is thickly globose and the compressed volutions are only acquired in later stages of growth. The first series is represented by *Meekoceras Khanikofi*, Oppel, and its allies, the second one by *Meekoceras Nalikanta*, *M. Srikanta* and *M. Narada*.

In the following table the corresponding height and thickness in millimetres of the volution in some species of the two series is given at different stages of growth for comparison, the same measurements in a true *Meekoceras*, *M. Hodgsoni* from the Otoceras beds, are added.

MEEKOCERAS KHANIKOFI, Oppel. (Cephalopoda of the Muschelkalk, Pl. XI, fig. 3.)

1					
Height	of the volution	42	28,	15,	8
Thickness	of the volution	20	17,	10·5,	6
2					
Height	of the volution	31	18,	11,	5
Thickness	of the volution	15	9·5	6·5	3·5

MEEKOCERAS NANDA, Dien. (Pl. IX, fig. 8).

Height	of the volution	18	9,	5,	3·5
Thickness	of the volution	7·5	5,	3·5,	2·5

MEEKOCERAS AFFINE, v. Mojs. (Pl. VIII, fig. 5).

Height of the volution	13	6
Thickness of the volution	7·5	4

MEEKOCERAS KESAVA, Dien. (Pl. VIII, fig. 6).

Height of the volution	25·5	10	4	3
Thickness of the volution	13	5·5	3	2·5

MEEKOCERAS HODGSONI, Dien.

Height of the volution	20	15	8	5·5	3
Thickness of the volution	10	7·5	5	4	2

MEEKOCERAS NALIKANTA, Dien. (Pl. IX, fig. 5).

Height of the volution	16·5	10	6	4
Thickness of the volution	11	8	6	4·5

MEEKOCERAS SRIKANTA, Dien. (Pl. VIII, fig. 9).

Height of the volution	21	14	8·5	5
Thickness of the volution	11	9	6	5·5

MEEKOCERAS NARADA, Dien. (Pl. VIII, fig. 7).

Height of the volution	25	10	5	3
Thickness of the volution	15·5	8	6	4

From this table it appears evident that, in young individuals of the three last mentioned species, a complete change takes place in the proportions of the transverse section. To a height of 6 or 7 mm. even, a transverse diameter of the same, or of greater, length corresponds. The inner volutions of these forms are consequently decidedly globose and very different in their shape from the full grown individuals. These three species will therefore have to be removed from the *Meekoceratinæ* and be placed into the genus *Proptychites*.

Proptychites Narada, *P. Nalikanta* and *P. Srikanta*, which have thus been demonstrated to belong to an evolutional series independent from the rest of the species, which I originally included in the genus *Meekoceras*, differ from the lower triassic species of *Proptychites* of the Salt Range by a more strongly falciform sculpture, which, however, differs from the system of sculpture exhibited in *Beyrichites*, Waagen. The latter genus is characterised by the strongly marked development of the crescent shaped exterior portion of the folds, and by their frequent combination with elongated tubercles at their commencement in the middle of the lateral parts, as for instance in *Beyrichites Nanda, B. Gangadhara, B. Rudra, B. proximus,* or in the variety of *B. Khanikofi*, figured in my memoir on the Cephalopoda of the Himálayan Muschelkalk in Pl. IX, fig. 2.

It is true, that the great similarity to typical species of the *Ptychites flexuosi* of the group of *Meekoceras reuttense*, Beyrich, and of *M. Khanikofi*, Oppel, for whose reception the genus *Beyrichites* has been created by Waagen, cannot be denied. This similarity in shape and sculpture is so great, that von Hauer in his studies on the Cephalopoda of Han Bulog in Bosnia discovered among his material, but quite accidentally by a preparation of its sutural line, a specimen of *Beyrichites reuttensis* previously confounded with *Ptychites flexuosus*,

Mojs., which is very frequent at the same locality.[1] A comparison of the sutural line, however, makes a distinction between *Beyrichites* and *Ptychites* a very easy matter and the mode of development of *Beyrichites*, provided with compressed whorls even in young stages, strictly forbids its being placed among the *Ptychitinæ*. In spite of a similarity in the general appearance of the full grown shell, no real affinity seems to exist between *Beyrichites* and *Proptychites*.

Although I am at variance with Waagen's views on the systematic position of *Beyrichites*, I fully concur in his opinion, that the group of *Meekoceras reuttense*, Beyr., comprises a good number of forms, which seem to be genetically connected among each other and are distinguished by sufficiently important characters, to justify a proper designation. I consequently accept the name *Beyrichites*, proposed by Waagen, but only as a subgeneric designation, and I consider *Beyrichites* to be a subgenus of *Meekoceras*, characterised in shape and sculpture, and recalling in general of the *Ptychites flexuosi*, *i.e.*, by falciform folds with a strongly expressed crescent shaped exterior portion, the commencement of which is often provided with protracted tubercles.

With regard to the *Meekoceratinæ* in general, it is chiefly the mode of development from globose, inflated young individuals by which *Proptychites* may be easily recognised. Another point of distinction is afforded by the arrangement of the sutural line.

The siphonal lobe is, as a rule, short, but nearly always provided with a high, often richly serrated siphonal prominence. Only one exception to this rule is known to me, *Proptychites Narada*, which is provided with a comparatively short, though richly serrated siphonal prominence, reaching only half as high as the siphonal saddle. In all the rest of the Indian and Siberian species the siphonal prominence recalls in its strong development *Ptychites*, *Sturia* or *Gymnites*, in which genera it almost acquires the importance of a true saddle.

The saddles are, as a rule, elongated and narrow, at least in the lower triassic representatives of our genus. In many species the lateral lobes are obliquely cut off along their exterior margins, as for instance in *Proptychites Markhami* (Pl. VI, fig. 6). These characters, however, do not hold good for the Muschelkalk species, the sutural line of which is very similar to that of *Beyrichites*.

In all my species of lower triassic age the sutural line is distinctly ceratitic and the auxiliary series rather simple, one single auxiliary lobe with the commencement of an adjoining saddle, or a prionitic row of indentations, being present only. The Muschelkalk species are, however, distinguished by a complicated auxiliary series. In *Proptychites Narada* the sutures are brachyphyllic, small incisions affecting even the very tops of the principal saddles.

In the lower trias of the Himálayas the genus is represented by four species. Three among them—all from the Otoceras beds—belong to the group of the *sadi*, Waagen, whereas the last one from the subrobustus beds must be placed among the

[1] *F. von Hauer.*—Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien, I. Neue Funde aus dem Muschelkalk von Han Bulog bei Sarajevo. Denkschriften kais. Akad. d. Wiss. Wien, math. nat. Cl., LIX, 1892, p. 281.

plicosi. It is closely allied to *Proptychites obliqueplicatus*, Waagen. Among the Himálayan representatives of the *nudi*, one must be considered as an isolated type, whereas two others bear close affinities to *P. oldhamianus*, Waagen, and to *P. discoides*, Waagen. All my Muschelkalk species form part of the *plicosi* group.

Thus we arrive at the following grouping of the species of *Proptychites*, which occur in the Himálayan trias—

I. Section : NUDI.

1. *Proptychites Markhami*, nov. sp., Otoceras beds.
2. „ *Scheibleri*, nov. sp., Otoceras beds.
3. „ *sp. ind.*, Otoceras beds.

II. Section : PLICOSI.

4. *Proptychites sp. ind. ex aff. obliqueplicato*, Waagen, subrobustus beds.
5. „ *Narada*, Dien., Muschelkalk.
6. „ *Srikanta*, Dien., Muschelkalk.
7. „ *Nalakanta*, Dien., Muschelkalk.

In the Salt Range the genus *Proptychites* is represented by twelve species, none of which, however, reaches higher up than the upper region of the Ceratite sandstone (Flemingites beds). In the Pacific region the presence of the genus has already been demonstrated by myself. Here it is represented by four species in the lower triassic sandstones of the Ussuri district and of the Island Russkij. Although Waagen has added a European form, *Meekoceras cadoricum*, v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, loc. cit. Pl. XII, fig. 9, p. 215), to this genus, the systematic position of this species seems to me still doubtful. From the general shape of the shell I should rather prefer to place this form somewhere near *Beyrichites reuttensis*, Beyr. Its whorls are even still more compressed than in E. v. Mojsisovics' type specimen, but the question could of course only be decided by a close examination of the specimen itself.[1]

I. Section : PROPTYCHITES NUDI.

A. Group of PROPTYCHITES OLDHAMIANUS, Waagen.

1. Proptychites Markhami, nov. sp. Pl. VI, fig. 4 a, b, 6 a, b, c.

Dimensions.

		Fig. 4.	Fig. 6.
Diameter of the shell		app. 63 mm.	66 mm.
„ „ „ umbilicus		10·5 „	9 „
Height of the last volution	from the umbilical suture	36 „	36 „
	„ „ preceding whorl	25 „	?
Thickness of the last volution		21 „	18 mm.

[1] *E. v. Mojsisovics* (Cephalopoden der Mediterranen Triasprovinz, l. c. p. 213) hints at the possibility, that *Gymnotoceras rotelliforme*, Meek. (Report of the Geol. Exploration of the fortieth Parallel, Vol. IV, Pt. i, p. 111, Pl. 10, fig. 9, 9 a), from the triassic rocks of the Humboldt Range in Nevada may belong to the group of *Meekoceras reuttense*. In this case the name *Gymnotoceras* would rightly claim priority before *Beyrichites* as a subgeneric designation. I am, however, far from being convinced of the relationship of *Gymnotoceras rotelliforme* to Waagen's *Beyrichites*. The American species in question is characterised by strongly inflated whorls, recalling *Proptychites*, and as Prof. Hyatt remarks (loc. cit. p. 112), a faint keel is occasionally shown on its siphonal side. I consequently prefer to retain Waagen's name *Beyrichites* for the group of *Meekoceras reuttense*, the true generic position of *Gymnotoceras rotelliforme* not being satisfactorily established at present.

Under this name I have to describe two fairly well preserved specimens, provided with parts of their body chambers, which seem to be closely allied to *Proptychites oldhamianus*, Waagen (Ceratite Formation, p. 166, Pl. XIX, fig. 3 a, b, c,) one of the geologically oldest species of the trias of the Salt Range.

In general shape and in the absence of any sculpture my specimens agree almost exactly with Waagen's species. The volutions are thickly lenticular, with a rounded and not very broad siphonal part. The lateral parts are almost flat and join the siphonal area in a distinct, though obtusely rounded off margin. The largest transverse diameter corresponds to the umbilical region. The umbilical margin is sharpened into a distinct edge and separated from the umbilical suture by a vertical wall, which in the last volution increases rather rapidly in height. The size and shape of the umbilicus is exactly as in *P. oldhamianus*. So is the configuration of the transverse section, bordered by barely arched lateral parts, which slope evenly from the umbilical margin towards the siphonal area. Only the distinct, obtusely rounded siphonal margin is absent in the Salt Range form, the rounded siphonal part of which unites with the flanks without forming any edge.

The overlap of the last over the penultimate whorl does not quite amount to one third of the height of the former. The involution does not take place exactly in the umbilical margin.

A narrow strip of the penultimate whorl is consequently left visible inside the umbilicus.

In one of my specimens the shell is partly preserved. It is perfectly smooth, without a trace of sculpture.

In the specimen, figured Pl. VI, fig. 6, a small fragment of the body chamber only is left. In the other specimen a little more than one quarter of the last volution forms part of the body chamber.

Sutures.—The sutural line is rather simple. The broad, very short siphonal lobe is divided by a siphonal prominence which almost reaches to the height of the siphonal saddle. The siphonal prominence is pyramid shaped and richly serrated. So is the siphonal lobe. At the base of each of its terminal branches, a larger denticulation is developed. Although it distinctly separates the two portions of each terminal branch of the siphonal lobe in the specimen Pl. VI, Fig. 4 b, it is certainly too small to be considered as an adventitious saddle.

The siphonal saddle is shorter than the principal lateral one. The second lateral saddle has a depressed top, as several Salt Range species of *Proptychites* such as *P. oldhamianus*, Waag., or *P. ammonoides*, Waag. All the saddles are obliquely rounded, as in *P. lawrencianus*, de Kon., their highest point being shifted towards the internal or umbilical side. In their upper portions they are bordered by parallel sides, which slope obliquely towards the siphonal margin, but are overhanging towards the umbilical region. The base of the lateral lobes is cut off obliquely on their external side and the indentations reach up much higher along this side than on the internal one. Even in the auxiliary lobe this tendency to develope a greater number of indentations along the external margin is distinctly

marked. All the lobes are strongly serrated. The auxiliary lobe is distinctly individualised and separated from the umbilical suture by a rudimentary auxiliary saddle.

In comparison with *P. oldhamianus* the species shows a more advanced development of the sutural line. In the Salt Range species the auxiliary series is only indicated by some dentations, which are all on the same level, whereas in our species a distinct auxiliary lobe is present. Other points of difference consist in the less strongly serrated lobes, which are bordered by parallel marginal walls, and in the broader shape of the saddles. In the general arrangement of the sutures our species bears a greater resemblance to *Proptychites latifimbriatus*, de Kon. (loc. cit. Pl. VII, fig. 2),[1] which, according to Waagen, belongs to the same evolutional series, as *P. oldhamianus*, but is provided with two distinct auxiliary lobes and saddles. Thus *P. Markhami*, which I attribute to the group of *P. oldhamianus* on account of its general shape and its narrow umbilicus, seems to hold an intermediate position between the latter species and *P. latifimbriatus*, in respect of the development of its sutural line.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Kiunglung encamping ground S.W. of Niti Pass, 1, Coll. Griesbach, 1, Coll. Diener; south of Kuling, Spiti 1, Coll. Griesbach.

Remarks.—It has already been pointed out that *P. oldhamianus* of the Salt Range forms of this genus is probably the nearest ally to this species. Both forms are however easily distinguishable by their sutural lines. Another form with which it might be compared is *P. lawrencianus*. It is however much more strongly inflated and provided with a broadly rounded siphonal area. Its auxiliary series consists of a long row of denticulations with an indistinctly marked first auxiliary lobe. *P. latifimbriatus* differs from our species especially by its thicker volutions and more complicated sutural line.

Among the materials from the Himálayan collection there is a very badly preserved specimen from the Otoceras beds of Kiunglung, which in general seems to be identical with *P. Markhami*, but exhibits traces of an ear-like, ridged umbilical margin, as has already been mentioned by Griesbach.[2] It is much to be regretted, that this specimen is so badly preserved, and that a figure would be useless. The presence of a species of *Proptychites* with ear-like ridges near the umbilical margin, recalling Griesbach's subgenus *Otoceras*, in the Indian Otoceras beds would be of great interest, as a similar form has actually been discovered in Eastern Siberia in homotaxially equivalent beds. I shall describe and figure this species as *Proptychites otoceratoides* in the Mémoires du Comité Géologique de la Russie XIV, No. 3, Pl. III, fig. 2. It imitates *Otoceras* exactly in its general shape, but is easily distinguished from the true representatives of this subgenus by a narrowly rounded (not sharpened) siphonal part and by its proptychitic sutures. But Griesbach's specimen is too fragmentary to allow any comparison with the Siberian species, especially as no trace of sutures is visible.

[1] *Waagen.*—Fossils from the Ceratite Formation, Pl. XVII, fig. 2, p. 170.

[2] *C. L. Griesbach.*—Palæontological notes on the Lower Trias of the Himálayas. Rec. Geol. Surv. Ind. XIII, p. 109.

B. Group of PROPTYCHITES DISCOIDES, Waagen.

2. Proptychites sp. ind. Pl. VI, fig. 5, a, b.

1889. Ptychites lawrencianus, Griesbach, *ex parte,* Palæontological notes on the lower trias of Himálayas, Rec. Geol. Surv. Ind. XIII, Pl. 2, p. 109.

This species is only represented in the Himálayas by a single fragment, of which it is impossible to take accurate measurements.

There is only the group of *Proptychites discoides,* Waagen (loc. cit. Pl. XX, fig. 1, 2, p. 175) among the Salt Range species, to which this form may be compared, owing to its discoidal shape and its compressed whorls, which have nearly parallel lateral parts.

To a height of 25 mm. of the whorl corresponds a thickness of 11 mm. The lateral parts are quite flat, thus the transverse diameter remains almost the same from the siphonal margin to the umbilical margin. A close examination only shows that the greatest thickness of the volutions coincides with the upper limit of their lower third.

The siphonal part is equally rounded and passes gradually into the lateral parts without forming an edge. The umbilical margin is sharply rounded. The distinct umbilical wall is very low, but vertical. Nothing can be ascertained of the shape and size of the umbilicus.

The involution of the shell is very inconsiderable. The overlap of the last over the penultimate whorl amounts to three eighths of the entire height of the former.

The fragment described here is composed of air chambers only.

Sutures.—The sutural line exhibits the same stage of development as in *P. discoides,* although it differs considerably in the details of its arrangement.

The principal lobes and saddles resemble in their configuration those of the preceding species (*P. Markhami*). The siphonal lobe is much shorter, than in *P. discoides.* It is broad, strongly serrated and divided by a high pyramid shaped siphonal prominence, which does not attain the height of the siphonal saddle. The latter is most characteristic owing to its remarkable height, surpassing in this respect all the rest of the saddles.

As in *P. Markhami* the tops of the saddles are obliquely shifted towards their internal or umbilical side. The saddles themselves slope less decidedly towards the siphonal part. The lateral lobes are bordered by parallel marginal walls which are obliquely cut off along their external portion near the base. Here the dentations reach considerably higher up, than along the internal wall. The auxiliary lobe is prionitic, being composed of a row of irregular indentations, which are all situated on the same level.

The saddles diminish in height in a very regular manner, the siphonal one being the highest. They are all long and narrow, and the second lateral saddle is somewhat depressed above.

Locality and Geological position. Number of specimens examined.—Otoceras beds, Kiunglung encamping ground S. W. of Niti Pass, 1, Coll. Griesbach.

Remarks.—As was stated in the introductory remarks to the description of this species, it seems to be closely allied to the group of *Proptychites discoides* and, more especially to *P. discoides*, Waag., itself. The general shape of the shell and the degree of development as regards the sutural line are identical in the two forms. Differences exist in the presence of a distinct umbilical edge and of a higher umbilical wall in the Salt Range species. The sutural line of *P. discoides* is distinguished by a deep siphonal lobe, by the equal height of the three principal saddles and by the equal breadth of the lateral lobe along their entire extent; all characters of which the reverse may be observed in this species.

Among the rest of the Salt Range forms *P. trilobatus*, Waagen (loc. cit. Pl. XX, fig. 3, p. 178), is the only one which is characterised by similar flat, compressed whorls, but the sutural line of this species has reached a much more advanced stage of development, a distinct auxiliary lobe being developed in the row of umbilical dentations.

C. ISOLATED SPECIES.

3. Proptychites Scheibleri, nov. sp. Pl. VI, fig. 3.

Dimensions.

Diameter of the shell	87 mm.
" " umbilicus	22 "
Height of the last volution { from the umbilical suture	43 "
Height of the last volution { " preceding whorl	33 "
Thickness of the last volution	29 "

This species differs rather widely from the other forms of the genus, hitherto described. I consider it as a member of the genus *Proptychites* especially on account of its inflated whorls and the character of its sutural line.

Our species is provided with a strongly inflated shell of somewhat elliptical outline, with rapidly increasing whorls and a comparatively large umbilicus. The inner volutions are not preserved. But from the shape of the last volution it may be inferred that a tolerably large number of whorls must be exposed within the umbilicus. Near the end of the last volution a slight egression from the normal spiral may be observed.

The overlap of the last over the penultimate whorl amounts to less than one quarter of the entire height of the former. The involution is not very considerable, the last volution overlapping the preceding one rather less than two thirds of its height. There are only *Proptychites magnumbilicatus*, Waagen (loc. cit. Pl. XIX, fig. 1, p. 173) among the Indian and *P. hiemalis*, Diener, among the Siberian representatives of the genus, in which a similar mode of involution is observed, all the rest of the congeneric species being distinguished by volutions, overlapping each other to a larger extent.

The transverse section of the volutions is cordiform. The largest transverse diameter coincides exactly with the upper limit of the lower third of the entire height of the whorls. From this point the lateral parts are bent in a graceful and very regular curve towards the umbilical suture, whilst towards the siphonal part they

converge in the shape of nearly flat, barely arched surfaces, passing into the equally rounded siphonal area without any distinct demarcation. At the beginning of the last volution the siphonal part is rather narrow and highly rounded, but towards the anterior termination it gradually changes to a regular semicircle.

The surface of the cast is perfectly smooth, without trace of sculpture. In the shell however, which is fairly well preserved near the anterior termination of the last whorl, very numerous and delicate falciform lines of growth may be observed; these lines of growth are arranged in bundles, separated from each other by intervals, in which striations rarely occur. These bundles seem to originate in a single point near the umbilical suture, but gradually diverge towards the siphonal part. Whether this latter is crossed by the striations or not, I have not been able to decide.

My specimen is entirely chambered.

Sutures.—The sutural line is especially remarkable by its very narrow and elongated saddles, bordered by parallel marginal walls and by the broad principal lobes, provided with dentations, situated all on the same level.

The siphonal lobe is broad but much shorter than all the rest. It is divided by a high, slender siphonal prominence which is not serrated but provided at its top with a distinct siphonal funnel. Each of the two branches of the siphonal lobe bears at its base only four dentations, which are all on the same level. In the two lateral lobes the base has three strong dentations, which are of the same arrangement as in the siphonal lobe, but accompanied by two smaller ones, situated a little higher and above the base of the marginal walls. The principal lateral lobe is much broader than the lateral branch of the siphonal lobe and reaches lower down than the second lateral one. The siphonal saddle is extremely narrow and almost as high as the principal lateral saddle. All the saddles are bordered by parallel marginal walls and are equally rounded above. Their walls are quite entire. The second lateral saddle is broader than the two other principal saddles, but comparatively still more slender and elongated than in the two preceding species. Our species has the shape of the auxiliary lobe and saddle in common with *P. Markhami*. The second lateral and the auxiliary lobes are on the same level. The auxiliary lobe is strongly serrated and cut off obliquely along its external side.

Owing to the bad state of preservation of the sutural line it is impossible to say whether the auxiliary saddle stands entirely outside the umbilical suture or not.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal cliff near Rimkin Paiar encamping ground; shales above the main layer of ***Otoceras Woodwardi***, Griesb., 1, Coll., Diener.

Remarks.—It was pointed out in the introductory remarks to the description of this species that it holds rather an isolated position in the genus and cannot be compared in particular with any described congeneric forms. It might consequently be questioned whether I have been correct in placing it among the genus *Proptychites*. One group of forms especially seems to be connected with the present species by a remarkable similarity in general shape of the shell. It is the group of

the *Ceratites nudi*, and among them chiefly *Ceratites Sturi*, E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Pl. XXXIX, fig. 1, p. 44). This species is also provided with inflated whorls, a still larger umbilicus and only a very faint sculpture. In its general shape and in the mode of involution *Ceratites patella*, Waagen (loc. cit., Pl. IV, fig. 2, p. 51) likewise shows some resemblance to our species. Points of difference of a specific importance are of course present in a sufficiently large number, but as the *Ceratites nudi* comprise so few species, which differ widely among themselves, it is only on account of the arrangement of the sutural line that I decided to consider the present species as a member of the genus *Proptychites*. The strong development of the siphonal prominence and the peculiar character of the saddles differs so much from anything hitherto discovered among the *Ammonea trachyostraca* that I am obliged to consider it as a representative of *Proptychites*, but as an isolated type of this genus.

II. Section: PROPTYCHITES PLICOSI.

4. PROPTYCHITES, SP. IND. EX AFF. P. OBLIQUEPLICATO, Waagen.

Dimensions.

Diameter of the shell		82 mm.
„ „ „ umbilicus		28 „
Height of the last volution	from the umbilical suture	36 „
	„ „ preceding whorl	24 „
Thickness of the last volution		25 „

The fragmentary specimen which represents this species in the Himálayan collection consists of the outer half of the last volution only. It is rather unfortunate that the only species to which it seems to be closely related, *viz.*, *Proptychites obliqueplicatus*, Waagen (loc. cit., Pl. XVII, fig. 3 *a*, 2 *b*, p. 183), from the middle region of the Ceratite sandstone of the Salt Range trias, is also founded on an imperfect specimen, in which only the outer half of the whorls is well preserved.

When first examining the specimen, I believed it to be a fragment of a *Hungarites* with a very wide and open umbilicus. It was only after having carefully chiseled out the siphonal part that I found the specimen had nothing in common with this genus, its siphonal part proving to be narrowly rounded, but not provided with a sharp keel, as it first appeared. Thus it becomes evident, both from the shape of the shell and from the arrangement of the sutural line, that the specimen must needs belong to *Proptychites*, and that its nearest ally was a Salt Range species, which takes a somewhat isolated position among the congeneric forms.

As much as can be ascertained from the fragment, the general shape of the shell seems to have been thick and disciform, with a comparatively large umbilicus and a narrowly rounded siphonal part. The overlap of the last over the penultimate volution amounts to exactly one third of the height of the former. But it is impossible to state the extent of the overlap of the volutions, as no trace of the inner whorls is left.

The transverse section of the last whorl is helmet or arrow shaped, recalling *Beyrichites Khanikofi*, Oppel, at younger stages of growth, or *B. kesava*, Dien.

The greatest transverse diameter corresponds about to the umbilical margin, being situated but very little above it. From this point the lateral parts converge towards the siphonal part in the shape of very slightly arched planes. The siphonal margin is not sharply defined, and the lateral parts pass gradually into the narrowly rounded siphonal area. The umbilicus is surrounded by a high perpendicular wall, which joins the lateral parts in a rounded off but distinctly marked umbilical edge.

The external portion of the sculpture is partly destroyed by weathering. Thick folds are distinctly marked near the umbilical region, of which there are five in this fragment. There may consequently have been nine to ten in the entire volution. This is also the number of folds in *P. obliqueplicatus*. But in the latter species the interior half of the lateral parts is so badly weather worn that nothing of the sculpture can be distinguished, whilst it is only in the lower portion of the lateral parts that the sculpture is distinctly developed in our species. The folds seem to flatten out gradually towards the siphonal margin, but they disappear entirely before reaching the siphonal area. Whether a division of each fold into two branches takes place in the external portion of the lateral parts, as in *P. obliqueplicatus*, cannot be decided.

My specimen consists of air chambers only.

Sutures.—The sutural line agrees tolerably well with that in *P. oliqueplicatus*, but is only known as far as the commencement of the second lateral saddle.

The second lateral lobe is met by the vertical projection of the periphery of the penultimate volution.

The siphonal lobe stands at a higher level than all the rest of the lobes. It is divided into two by a high siphonal prominence, the details of which I was not able to examine. The lateral branches of the siphonal lobe are strongly dentated at their base, the points of the indentations being directed towards the adjoining siphonal saddle. The siphonal saddle is slightly contracted at its base, but not so decidedly club shaped as in the Salt Range form. Its marginal walls are entire, and its apex is narrowly rounded. The principal lateral saddle is both higher and broader than the siphonal saddle, and its top is shifted somewhat towards the internal or umbilical side. In its lower portion it is bordered by almost parallel marginal walls. The principal lateral lobe is the deepest among all, and provided with sharp elongated denticulations at its base, which together form a very prominent arch. At the base of the second lateral lobe the denticulations are arranged in a considerably flatter curve. The second lateral saddle is comparatively short, very narrow, rounded at its apex, and bordered by parallel marginal walls. The broad auxiliary lobe is on the same level as the second lateral lobe. It is divided by the umbilical margin and is strongly serrated. It is followed by a distinct auxiliary saddle, which is quite outside the umbilical suture.

Locality and Geological position. Number of specimens examined.—Subrobustus beds, Kiunglung encamping ground, S.W. of Niti Pass, 1, Coll., Diener.

Remarks.—This form is very closely allied to *P. obliqueplicatus*, Waagen, as far as can be made out from two rather fragmentary specimens, on which the two

species in question have been founded. In general shape and mode of involution they agree very well, and in the sutural line they differ only in minor details. The chief points of difference consist in the stronger development of the folds in the Salt Range species and in the backward direction of the folds on the upper portion of the lateral parts.

Thus the two forms, though they are very closely related, certainly belong to different species; but there are no other species of the genus ***Proptychites***, to which ***P. obliqueplicatus*** or the present form might advantageously be compared.

GYMNITINÆ, Waagen.

Genus: XENASPIS, Waagen.

Subgenus: VISHNUITES, nov. subgen.

1872. *Ceratites carbonarius*, Waagen, Mem. Geol. Surv. Ind., IX. p. 355, Pl. I, fig. 2, 3.
1879. *Xenodiscus carbonarius*, Waagen, Salt Range Fossils, Palæont. Indica, ser. xiii, I, Productus Limestone Fossils, Pl. II, fig. 2-5, p. 35.
1895. *Xenaspis*, Waagen, Salt Range Fossils, Palæont. Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 161.

In 1879 Waagen introduced the new genus ***Xenodiscus*** for a number of species from the permian and triassic strata of the Salt Range, characterised by very numerous, but only slightly overlapping volutions, by a wide, open umbilicus, and by ceratitic sutures. Later researches have shown, however, that in this genus, as proposed by Waagen originally, three very different elements had become mixed up. The type of a first group is represented by ***Xenodiscus plicatus***, Waagen (Productus-Limestone Fossils, p. 34, Pl. II, fig. 1); the type of a second one is constituted by ***Xenodiscus carbonarius***, Waagen, whereas a third group comprises a large number of triassic forms, apparently related to the last mentioned species.

E. v. Mojsisovics was the first to recognise two different elements, which had been originally included in the genus ***Xenodiscus***. He removed ***X. plicatus*** from this genus and placed it in his group of the Arctic ***Ceratites obsoleti*** (subgenus ***Danubites***, v. Mojs., 1893) on account of its strong sculpture, recalling the ***Ammonea trachyostraca***.[1] He consequently retained the generic designation of ***Xenodiscus*** for ***X. carbonarius*** only and for the similar triassic forms, which he rightly pointed out to be closely allied to ***Meekoceras***, Hyatt. In the genus he also included a number of lower triassic species from the Himálayas, for which the generic name of ***Ophiceras*** had meanwhile been proposed by C. L. Griesbach.[2]

In his great memoir on the triassic Cephalopoda of the Salt Range, Waagen takes an entirely different view of the systematic position of ***Xenodiscus***. He does not agree with E. v. Mojsisovics in placing ***Xenodiscus plicatus*** among the ***Cera-***

[1] *E. v. Mojsisovics*,—Arktische Triasfaunen, Mém. de l' acad. des sciences de St. Pétersbourg, sér. VII, XXXIII, No. 6, 1886, p. 20.

[2] *C. L. Griesbach*,—Palæontological Notes on the Lower Trias of the Himálayas, Rec. Geol. Surv. Ind., XIII, 1880, p. 109.

tites obsoleti (or *Danubites* according to the latest terminology), but considers this species to be the prototype of a proper genus. This genus is distinguished from *Danubites* by a longer body chamber, occupying nine tenths of the last volution. This point of difference is even considered by Waagen as of sufficient importance to remove *X. plicatus* not only from *Danubites* but from the family *Ceratitidæ* altogether and to transfer it to the *Celtitinæ*, characterised by a long body chamber, which occupies from one to one and a half volutions. As however *X. plicatus* was the first species, described by Waagen as *Xenodiscus*, it must be considered as prototype of the genus according to the rules of palæontological nomenclature. But the two other groups of forms, originally united in the genus by Waagen, must be removed from this genus and be given a new generic designation.

It is true, that *Xenodiscus carbonarius* was described by Waagen before *X. plicatus* (in Mem. Geol. Surv. of India, 1872, Vol. IX, p. 355), but unfortunately as *Ceratites*, no new generic designation having been proposed for the Salt Range forms in question. In the original diagnosis of *Xenodiscus* in 1879 none of the species united in this genus had been designated by Waagen as the typical one; nor is it possible to find out any reason for excluding *Xenodiscus plicatus* from the definition of the genus. Waagen is therefore perfectly correct in considering *X. plicatus* as prototype of the genus *Xenodiscus*. According to the rules of priority there is really no other way out of the confusion which exists with regard to the nomenclature of the lower triassic ammonites, owing to an erroneous interpretation of this generic name.

Waagen pleads for a separation of *X. plicatus* from *Danubites* chiefly on account of two reasons, namely, owing to the different length of the body chamber and the character of the sutural line.

In *X. plicatus* the body chamber occupies nine tenths of the last volution, whereas in the *Ceratitidæ* one half or but exceptionally three quarters of the last volution is part of the body chamber. It is true, that several arguments may be raised against this view. It may be mentioned at once that the length of the body chamber is altogether a rather variable character, to a certain extent at least, and that in the family of the *Tropitidæ*, for instance the length of the body chamber varies even in one and the same species. A distinct boundary between forms with long and short body chambers can scarcely be drawn, if one adheres strictly to this character. The representatives of the genus *Ptychites* for instance, as far as they are known in this respect, are provided with a body chamber, which as a rule does not exceed in length three quarters of the last volution. *P. euglyphus*, v. Mojsisovics (Arktische Triasfaunen, pp. 89, 94, Pl. XIV, fig. 1, 2, 3) makes an exception, being provided with a body chamber, which almost occupies the entire last volution. But *P. euglyphus* is so closely allied to its congeneric species from the Arctic trias, that on account of this reason alone nobody would think of removing it from the genus *Ptychites*, or of placing it among the *Arcestidæ* distinguished by their long body chamber.

On the other hand it ought not to be overlooked, that even in this instance the

difference in the length of the body chamber between *Ptychites euglyphus* and the congeneric species is far from being so remarkable as between *Xenodiscus plicatus* and any one of the hitherto known *Danubites*. In all the Himálayan *Danubites*, which as regards their sculpture bear the greatest similarity to *X. plicatus*, the body chamber occupies but very little more than one half of a volution. From these forms *X. plicatus* consequently differs in this character in a rather remarkable way, and it cannot be denied that this character is of an undoubtedly important generic value, as it is closely connected with the interior organisation of the individual.

Waagen asserts a second character, namely, that of the sutural line in *Xenodiscus plicatus*.

It was demonstrated by E. v. Mojsisovics (loc. cit. p. 12), that true *Ceratites* with two lateral lobes are gradually developed from *Dinarites spiniplicatus*, Mojs., a species provided with one single lateral lobe only. But *Xenodiscus plicatus* had already in permian times acquired the normal number of principal lobes. It therefore cannot be intimately connected with *Danubites*, which in lower triassic times had only just been developed from an original form with a single lateral lobe.

This argument has proved to be insufficient on closer examination of the Himálayan material. In the lower trias of the Salt Range, it is true, some representatives of the genus *Dinarites* with a smaller than the normal number of principal lobes are known, but no *Dinarites* has yet been discovered in the lowest trias of the Himálayas, *i.e.*, in the Otoceras beds, whereas typical species of *Danubites* with the normal number of principal lobes are rather frequent. According to its sutural line *Xenodiscus plicatus* might consequently be considered to be an ancestor of *Danubites*, were it not for the marked difference in the length of the body chamber as in its sutural line it represents a somewhat lower stage of development by the absence of an individualised auxiliary lobe. In this case the presumptive ancestors of *X. plicatus*, corresponding to the *Dinarites spiniplicati* of the Siberian Olenek beds ought to be looked for in lower strata than the Cephalopoda beds of the upper Productus limestone.

Nevertheless the remarkably greater length of the body chamber in *Xenodiscus plicatus* appears also to me to be a character of sufficient importance, to constitute this species as the prototype of a proper genus, which must be separated from *Danubites*. Waagen removes the genus from the Ceratitidæ altogether and places it among the *Propitidæ* (subfamily *Celtitinæ*), although its body chamber comprises a little less than one entire volution. To this proceeding an analogy may be found in E. v. Mojsisovics' classification of the *Tropitidæ* to which family this author himself has added the genus *Sagenites*, although in the groups of the *Sagenites spinosi* and *S. reticulati* the body chamber occupies less than one volution and in some species with narrow and compressed whorls even scarcely more than one half of a volution.[1]

[1] E. v. *Mojsisovics*, Die Cephalopoden der Hallstätter Kalke: Abhandlungen k. k. geol. Reichs-Anst. VI, 2, Hälfte, 1893, p. 155.

The triassic forms of the Salt Range, belonging to the two other groups which Waagen had previously included in the genus *Xenodiscus*, and which are most closely related to *Meekoceras*, Hyatt, have now been placed by this author in his last memoir, under the new generic designation *Gyronites*.[1] This genus will be fully discussed later on. The second group, represented by *Xenodiscus carbonarius*, Waagen, also forms the type of a new genus, for which the name *Xenaspis* is introduced.

From *Gyronites*, Waagen (*Meekoceras* Mihi), and from *Ophiceras*, Griesbach, to which this genus bears a striking similarity in its general shape, it is especially distinguished by the presence of a longer body chamber. In none of the specimens of *Ophiceras*, which is very largely represented in the Himálayan collections, does the length of the body chamber exceed half a volution by more than one twelfth part of the entire periphery of the last whorl. The same remark applies to the species of *Gyronites*, described by Waagen from the Ceratite beds of the Salt Range, whereas in *Xenaspis carbonaria* the body chamber occupies nearly the entire last volution.

Xenaspis carbonaria of permian age is already provided with distinctly serrated lobes, like *Ophiceras* or *Gyronites* of lower triassic age, but differs by the absence of an auxiliary lobe. Among the lower triassic fauna of the Island Russkij (Eastern Siberia), which is approximately homotaxial to the Himálayan Otoceras beds, D. L. Iwanow has discovered a form which is distinguished by a body chamber which exceeds three quarters of the last volution in length and which must consequently be considered to belong to *Xenaspis*. In this species, which I am going to describe in the Mémoires du comité géologique de la Russie (XIV. N. 3, Pl. III, fig. 3), under the name of *Xenaspis orientalis*, the sutural line is in a much further advanced stage of development than in any *Ophiceras* or *Gyronites*, the base of its lobes being provided with strong digitations, and a distinct auxiliary lobe being represented in the umbilical series of denticulations.

To these two forms a third one must probably be added, which I described in my Memoir on the Cephalopoda of the Himálayan Muschelkalk as *Xenodiscus Middlemissi* (Pl. XXX, fig. 6), from the triassic limestone crags of Chitichun.[2] In this species, it is true, the length of the body chamber is not known; it differs however so remarkably from *Ophiceras* and *Gyronites* by its extremely flat shell and by the very narrow, compressed whorls, bordered by very flatly arched lateral parts, whereas on the other hand in these characters as well as in the development of the sutural line it is so closely allied to *Xenaspis orientalis*, that I am obliged to consider it as a member of the genus *Xenaspis*[3].

[1] Jahrbuch k. k. geol. Reichs-Anst. XLII. 379, and Rec. Geol. Surv. Ind., XXV, 183.

[2] It was only after the publication of this Memoir, that Waagen's latest views regarding the systematic position of *Xenodiscus* became known to me. I consequently accepted the genus in the range attributed to it by E. v. Mojsisovics.

[3] I may add, that most of the specimens, coming from this locality consist of air chambers only, and that in none of them has more than one half of the body chamber been preserved. *Procladiscites*, which is rather frequent at Chitichun, is provided with a long body chamber, but in none of the specimens does the remnant of the body chamber amount to more than one half a volution.

In the same Memoir a second species was described and figured (Pl. XXX, fig. 4.) as *Xenodiscus nov. sp. ind.* This form I also prefer to consider, at least provisionally, as belonging to *Xenaspis*. As has been pointed out in the special description, it seems closely allied to *Gymnites* owing to its particular sculpture. It is however difficult to pronounce a decision as to its systematic position, because the length of the body chamber cannot be made out from the fragment described, and also because the sutures have suffered considerably from weathering.

The examination of the forms, which are considered to be representatives of the genus *Xenaspis*, seems to point to the conclusion that they constitute together a natural genetic series, in which the development of the sutural line takes place more rapidly than in *Ophiceras* or in *Gyronites*, which are both distinguished by a shorter body chamber. It is therefore perhaps justifiable, to separate *Xenaspis* from the two genera mentioned, not only on account of the difference in the length of the body chamber but also owing to the different course of development which their sutural line takes in the lower triassic time.

Two species of the genus *Xenaspis* are up to now established with certainty, to which two more will probably have to be added. According to their geological distribution they may be arranged as follows :—

1. XENASPIS CARBONARIA, Waagen.

Salt Range, permian (upper Productus limestone).

2. X. ORIENTALIS, Dien.

Eastern Siberia, lower trias (Otoceras beds).

3. X. MIDDLEMISSI, Dien.

4. X. (?) NOV. SP. IND., Dien.

Both from the limestone crags of Chitichun, Tibet probably lower Muschelkalk.

Waagen considers the genus *Xenaspis* to be representative of *Gymnites* in permian times. There are important reasons which support this view and against the supposition that this genus is the ancestor of *Ophiceras*, Griesb.

Gymnites Ugra (Cephalopoda of the Muschelkalk, Pl. XXX, fig. 6.) the geologically oldest true *Gymnites* from the triassic limestone crags of Chitichun, is provided with sutures, which have only just passed from the ceratitic into the gymnitic stage, and consequently is still very closely related to *X. Middlemissi*, as was pointed out in my former Memoir.[1] Most species of *Ophiceras* acquire a distinct lateral sculpture which consists either of folds or already of irregular elevations in young stages of growth, whereas *Gymnites* attains a well developed lateral sculpture only in the full grown stage. In this respect the similarity with *Xenaspis* is very remarkable, as was pointed out by Waagen. In *Xenaspis* the inner volutions are always smooth or covered only with very delicate radial folds, whereas

[1] Infra Pt. ii, p. 117.

a well developed lateral sculpture, if it is developed at all, is restricted to the last volution. An important character of *Ophiceras* which recalls *Flemingites*, Waagen, consists in the presence of a very delicate spiral striation, which I have observed on the cast of a great number of specimens. But in none of the species of *Xenaspis* or *Gymnites* has this character been noticed.

A species from the Himálayan Otoceras beds is as closely allied to the genus *Xenaspis* as *Buddhaites Rama* (Cephalopoda of the Muschelkalk Pl. XIII, fig. 3, XIV, fig. 1, 2) is to a true *Gymnites*. In general shape, in volution, and the length of the body chamber this species agrees very well with *Xenaspis*, but differs by a very sharp, knife like siphonal edge. I consequently prefer to consider this species to be the prototype of a proper subgenus, for which the name *Vishnuites* is introduced.

The subgeneric characters can be easily understood from the following description of the only species by which this subgenus is represented in the Himálayan collection.

1. Vishnuites Pralambha nov. sp, Pl. VII. fig. 4, 5.

Dimensions.	fig. 4.
Diameter of the shell	57 mm.
,, ,, ,, umbilicus	19 ,,
Height of the last volution { from the umbilical suture	23 ,,
Height of the last volution { ,, ,, preceding whorl	17 ,,
Thickness of the last volution	8 ,,

This species recalls in a striking manner some forms of *Pinacoceras*, in its outlines, especially of the rather strange species first described by E. v. Mojsisovics as *Pinacoceras neglectum*,[1] which will probably have to be looked upon as the representative of a proper subgenus, although transferred later on by the same author to *Gymnites*[2] on account of its sutural line.

The general shape of the shell is very flat and disciform, with slowly increasing numerous whorls and a wide umbilicus as in *Xenaspis orientalis*. The volutions overlap each other to the extent of a little more than one half of their entire height.

The transverse section is almost three times as high as broad, in the last volution of the smaller specimen, corresponding to a diameter of the shell of about 60 mm. The largest transverse diameter is situated a little below the middle of the height of the whorl. The lateral parts are quite regularly arched and join in a knife like, sharpened siphonal edge. They slope very gradually, and without any intervention of an umbilical wall or margin, to the umbilical suture. They thus join the lateral parts of the preceding whorls under a very flat angle, and in this the shape of the plate shaped umbilicus recalls the flat umbilici of *Pinacoceras Damesi*, v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Pl. LII., fig. 9, p. 195) and its allies.

[1] E. v. *Mojsisovics*, Das gebirge um Hallstatt, I. Theil: Abhandlgn k. k. geol. Reichs-Anst, VI. 1873, Pl. XXVII, fig. 2. p. 66.

[2] E. v. *Mojsisovics*, Cephalopoden der Mediterranen Triasprovinz, *ibid.*, X, p. 232.

As in ***Buddhaites Rama*** the knife-shaped siphonal edge is not developed in very young stages of growth. The innermost volutions up to a diameter of the shell of 13 mm. are provided with a distinctly rounded siphonal part. In advanced age the siphonal part is not only decidedly sharpened, but also accompanied by a very delicate spinal groove along each side, as is described by E. v. Mojsisovics in ***Gymnites*** (?) ***neglectus***. In the body chamber of the larger of the two specimens (fig. 5) these spinal grooves are clearly visible along the siphonal edge, but they are too delicate to allow a distinct reproduction in the figure.

The chambered part of the volutions is free from sculpture. Even in the body chamber of my larger specimen the ornamentation is rather delicate, and consists of irregular wrinkles or narrow folds, which are of about the same character as in ***Ophiceras Sakuntala***. The folds or wrinkles exactly correspond in their direction to the numerous, delicate lines of growth, which cover the surface of the shell. They are strongly bent forward in the umbilical region, and slightly falciform in the upper portion of the lateral parts, being again curved forward near the siphonal edge. Some of the wrinkles even touch the latter and join with those of the other side.

I do not know the length of the body chamber exactly, but it must comprise at least three quarters of the last volution in the last-mentioned specimen, no traces of the sutural line being visible at the spot where this volution is broken off.[1]

Sutures.—The sutures are almost perfectly identical with those in many species of ***Ophiceras***, Griesb., especially in *O. Sakuntala*, Diener, with the one exception, however, that in the auxiliary series of umbilical denticulations a more irregular arrangement is exhibited, showing a slight progress in the tendency of developing more distinct auxiliary elements.

The siphonal lobe is somewhat broad and short and divided by a high siphonal prominence, provided with slightly arched margins and with a distinct siphonal funnel above. The two lateral branches are denticulated at their base. The principal lateral lobe is considerably deeper than the rest. It is strongly serrated at its base, the dentations forming together a narrow arch. The second lateral lobe is likewise serrated and is on the same level with the auxiliary series. The siphonal and principal lateral saddles are of equal height, but the latter is much broader. The second lateral saddle is rather short and small.

The auxiliary series is composed of numerous, unequally-sized denticulations. There are, however, indications of a tendency to a division into two distinct elements. In the portion adjoining the second lateral saddle the indentations are, as a rule, very small and regular, whereas in the umbilical portion of the series a much more irregular arrangement takes place. On the specimen (fig. 4a) this arrangement is unequal in different septa, but in most of them a coarse and comparatively larger denticulation marks the boundary between the two portions of the auxiliary series. This development of the auxiliary series somewhat recalls the subgenus ***Kingites***, Waagen (Ceratite Formation, p. 207).

[1] It is the lowest point in the figure.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground 2, Coll. Diener.

Genus: FLEMINGITES, Waagen.

1892. *Flemingites*, Waagen, Jahrb. k. k. geol. Reichs-Anst., XLII, p. 380.
1893. *Flemingites*, Waagen, Rec. Geol. Surv. Ind., XXV, p. 184.
1895. *Flemingites*, Waagen, Salt Range fossils, Pal. Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 185.

The genus *Flemingites* was introduced by Waagen for some of the most conspicuous and strangest ammonites, which exist in the triassic deposits of the Salt Range. *Ceratites flemingianus*, de Koninck (Quart. Jour. Geol. Soc., XIX, p. 10, Pl. VII, fig. 1), is considered to be prototype of this genus. The disciform shell, a rather small involution, which results in a very large and flat umbilicus and a distinct concentric or spiral striation, are among its most remarkable characters.

Outside the triassic deposits of the Salt Range, where *Flemingites* is represented by not less than seven species, no representative of this strange genus was known with certainty up to now. Waagen, it is true, pointed out that *Ceratites crasseplicatus*, v. Hauer,[1] and *C. striatus*, v. Hauer,[2] might most probably belong to *Flemingites*, but to me their relationship to this genus does not seem to be proved in a convincing manner. Both in their sutural line and in the comparatively thick transverse section of their volution they remind one more of true *Ceratites* than of *Flemingites*. As regards their sutural line I have pointed to its similarity to *Saponites* in my memoir on the Cephalopoda of the Muschelkalk. The presence of a spiral striation, which is, however, barely perceptible in *C. crasseplicatus*, cannot be looked upon as a decisive character, as it is most magnificently developed in *Ceratites Oebergi*, v. Mojsisovics (Arktische Triasfaunen, Pl. VIII, fig. 3, p. 33.), most certainly a true *Ceratites* of the *Polaris* group, owing to its falciform ribs, rising in strong umbilical thorns. I may add that my suggestion, that *C. striatus* and *C. crasseplicatus* actually belong to the genus in which they had been placed originally by F. v. Hauer, is not only based on the figures and description given by this author, but is confirmed by a personal examination of von Hauer's materials in the collection of the Vienna Natural History Museum.

True representatives of the genus *Flemingites* are, however, present in the lower trias of the Himálayas. Here the genus is represented by four species, three of which occur in the subrobustus beds, whereas a single one is already met with in the Otoceras beds of Spiti, together with *Nannites hindostanus*. Thus in the Himálayan trias the genus makes its appearance in somewhat lower beds than in the Salt Range, where all the species described by Waagen are confined to the Ceratite

[1] F. v. *Hauer*, Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien. Neue funde aus dem Muschelkalk von Han Bulog bei Sarajevo. Denkschr. kais. Akad. d. Wiss. Wien, LIX, 1892, Pl. IV, fig. 2, p. 264

[2] *Ibid.*, Pl. IV, fig. 1, p. 263.

sandstone, which occupies approximately the same position as that of the Himálayan subrobustus beds.

The three species belonging to the latter horizon are closely related to Salt Range forms. Two of them have their nearest allies in *Fl. trilobatus*, Waag., and in *Fl. compressus*, Waag., whereas the third one probably belongs to the group of *Fl. glaber*, Waag., although the strange development of the siphonal lobe is not so distinctly marked as in the Salt Range species.

To the characters of the genus, as they were described by Waagen, no new information can be added after the examination of the Himálayan species. In one of my specimens of *Flemingites Rohilla* the body chamber comprises exactly one half of the last volution in length. But as no trace of the margin of the apertural is preserved, the total length of the body chamber probably did exceed one half of a volution.

According to their affinities and geological distribution the Himálayan species of this genus may be grouped as follows :—

a. Group of Flemingites nanus,

1. *Fl. sp. ind. ex aff. trilobato*, subrobustus beds.

b. Group of Flemingites glaber,

2. *Flemingites Rohilla*, n. sp., subrobustus beds.

c. Group of Flemingites flemingianus, de Kon.

3. *Flemingites Salya*, n. sp., subrobustus beds.

d. Isolated species.

4. *Flemingites guyerdeti*, n. sp., Otoceras beds.

As regards the systematic position of *Flemingites* I fully agree with Waagen in placing this genus among the *Ammonea leiostraca* and as a member of the *Gymnitinæ*, in spite of the comparatively strong sculpture which is developed in some of the Salt Range species. The configuration of the siphonal lobe in the sutural line and the tendency to develop adventitious elements are such remarkable characters, that they must be considered as being of the highest importance for the systematic position of the genus. In none of the Himálayan species is a strong sculpture to be seen. They are either perfectly smooth (*Fl. guyerdeti*) or provided with broad, flat folds of insignificant character.

Group of FLEMINGITES NANUS, Waagen.

1. Flemingites sp. ind. ex aff. trilobato (Waag.); Pl. XVII, fig. 2.

Dimensions.

Diameter of the shell		69	mm.
" " " umbilicus		24	"
Height of the last volution	from the umbilical suture	28	"
	" " preceding whorl	24·5	"
Thickness of the last volution		14	"

We possess only a single specimen of this species and this even has been much weathered. It is very closely allied to *Flemingites trilobatus*,[1] Waagen, from the upper region of the Ceratite sandstone. As my specimen is not sufficiently well preserved to merit a new designation, I prefer to describe it tentatively as *sp. ind.*, although better material may even prove its identity with the Salt Range species, to the nearest allies of which it certainly belongs.

The general shape of the shell is disciform, with compressed whorls and a very flatly rounded siphonal area, bordered by sharply rounded off marginal edges. The whorls overlap each other, but very little that of the last volution over the penultimate one amounting to about one quarter of the height of the latter.

The transverse section of the last volution is twice as high as broad. The largest transverse diameter corresponds to the lower third of the entire height. The lateral parts are but flatly arched and are separated from the broad, siphonal part by rounded off marginal edges, as has been stated above. In the inner volutions the siphonal part is flatter and the marginal edges are more distinct than in the last whorl. The same phenomenon is exhibited by many forms of the *Meekoceratidæ*, for instance by the group of the *Gyronites semirotundati*, Waagen. The lateral parts slope in a very regular curve to the umbilical suture without forming any umbilical edge. The last portion of this slope above the umbilical suture is rather steep, but cannot be considered to be a distinct umbilical wall.

The sculpture consists of flat radial folds, similar in shape and strength to those in the group of the *Ptychites rugiferi*. They originate near the umbilical suture and gradually die out before reaching the siphonal margin. The surface of my specimen is too much weathered to allow an opinion being expressed as to whether the unequal strength of different folds is a proper character of the species, as is the case in *Flemingites trilobatus*, or is due to the irregular weathering of the shell. There may have been about seventeen folds in the last volution, but they are not regularly distributed, and arranged at unequal distances. The sculpture of the inner whorls has been quite destroyed.

As there is no trace of the shell preserved, nothing of the spiral striation is seen, which is so distinctly marked in *Fl. trilobatus*. Traces of a spiral striation are, however, visible on the cast in a few places of the siphonal area, especially near the anterior termination of the last whorl.

The specimen is composed of air chambers only.

Sutures.—The sutures agree almost perfectly with those in *Fl. trilobatus* with the exception of the auxiliary saddle, which is considerably smaller and less distinct in our specimen.

The siphonal lobe is very broad, and distinguished by a very conspicuous indentation in each of its lateral branches. The outer portion of the lateral branch, adjoining the siphonal prominence, is rather short and small, whereas the inner portion is provided with strong denticulations and rises to the same level as the second

[1] *W. Waagen*, Salt Range fossils, Pal. Indica, ser. xiii, II, Fossils from the Ceratite Formation, Pl. XVI, fig. 2, p. 198.

lateral lobe. The principal lateral lobe is considerably deeper than the siphonal one and strongly serrated, the denticulations at the sharply rounded base of the lobe being much longer than those along the marginal walls. The siphonal and principal lateral saddle are of almost equal size, the latter exceeding the former but very little in height. They are contracted below and broadly rounded above and without any indentations. The second lateral lobe resembles the principal one in shape, but is on a smaller scale. The second lateral saddle is likewise contracted below and slightly depressed above, where it is broadly rounded. It is followed by an auxiliary lobe, which is remarkably shorter and narrower than the second lateral lobe; from this lobe the sutural line rises but very slightly to a shallow auxiliary saddle, which is quite indistinctly separated from the preceding lobe.

Locality and Geological position. Number of specimens examined.—Subrobustus beds, S.E. of Muth, Spiti 1, Coll. Griesbach.

Remarks.—As far as conclusions may be drawn from such a poor specimen, it exhibits a striking similarity to *Fl. trilobatus*, Waagen. It must be borne in mind, however, that owing to weathering it is impossible to say whether some of the important characters of the Salt Range species are present or not, for instance the arrangement of the spiral striations on the shell, and the sculpture of the inner volutions, which is rather characteristic in *Fl. trilobatus*, one weaker fold being generally intercalated between two stronger ones. The similarity of the sutural lines in the two species is very remarkable, especially the almost absolute identity in the development of the extraordinarily broad siphonal lobe and in the shape of the following lobes and saddles. In comparison to these characters the difference in the shape of the auxiliary saddle is of minor importance.

However, I prefer to consider this specimen as a proper species, leaving it to future researches to decide whether it may not have to be united with the Salt Range species as a variety.

Group of FLEMINGITES GLABER, Waagen.

2. Flemingites Rohilla, nov. sp. Pl. XVIII, fig. 2, 3, 4; Pl. XXIII, fig. 1.

Dimensions.

	Pl. XVIII, fig. 3	fig. 4.
Diameter of the shell	113 mm.	79 mm.
" " " umbilicus	50 "	29 "
Height of the last volution { from the umbilical suture	37 "	26 "
Height of the last volution { " " preceding volution	32 "	22 "
Thickness of the last volution	app. 18 "	12·5 "

This species is represented by four specimens, of which two are fairly well preserved. One of these specimens, which I collected in the subrobustus beds of the Shalshal cliff, has part of the shell preserved, distinctly showing the delicate spiral striation so characteristic of this genus. This specimen (Pl. XVIII, fig. 4) should be considered as prototype of the species.

The species is very flatly disciform, with compressed whorls, a flattened siphonal part and a wide and shallow umbilicus. The volutions overlap each other to the extent of rather less than one quarter of their height.

The transverse section is a little more than twice as high as broad, its largest transverse diameter being situated a little below the middle of the height of the volutions. The lateral parts form a flat arch. They slope regularly towards the umbilical suture into which they pass without forming an umbilical edge or wall. Only near the anterior termination of the largest specimen (Pl. XVIII, fig. 2) an indistinct, rounded umbilical wall is indicated by the last, steep portion of the curve, in which the lateral parts bend down to the umbilical suture.

The siphonal part is perfectly flat and bordered by distinct, sharp margins, which persist even in later stages of growth. The species should consequently be considered to belong to the *Flemingites biangulares*, whereas in the Salt Range only *rotundati* or *semirotundati* are known. But the biangular shape of the siphonal area is certainly of too indifferent systematic value to justify the grouping together of forms on account of this character alone.

The sculpture recalls that of *Flemingites radiatus*, Waagen (Ceratite Formation, Pl. XI, fig. 1, p. 197). It consists of numerous, flat and broad radial folds, which are seen on the inner volutions, but become weaker towards the commencement of the body chamber and disappear completely on the latter. The folds are quite straight, broadly rounded above and extend across the lateral parts, from the umbilical region to the siphonal margin, which, however, they do not reach. Their strength varies in different specimens. They are more distinctly developed in the specimens figured Pl. XVIII, fig. 2 and 3, and are most strongly developed near the anterior portion of the penultimate whorl, whereas in the body chamber they are completely absent. In the first specimen they are very equally distributed but gradually die out towards the anterior termination of the shell, although the latter is still entirely chambered. In the remainder of the specimens the sculpture is but faintly represented on the inner, and completely disappears in the anterior portion of the last volution. The number of folds likewise varies; on the last volution of the largest specimen (Pl. XVIII, fig. 2) they occur at very irregular intervals. On the sculptured part of this volution—comprising about three quarters of it—seventeen to eighteen folds may be counted, whereas there are only eleven to twelve in the penultimate whorl. But the character of the sculpture, in spite of the irregularity of the strength and arrangement of the folds, remains the same in all the specimens, and consist of low, broad, single, radial folds, and consequently the slight differences noted seem to me of too insignificant importance to justify a separation of the specimens figured Pl. XVIII, fig. 2 and 3, even as mere varieties of the same species.

In the type specimen (Pl. XVIII, fig. 4) part of the shell is preserved, showing a concentric spiral striation, consisting of numerous, delicate striae, which are separated by slightly irregular intervals. On the internal cast this spiral striation appears considerably weaker, but also quite distinct, although only in places which have not been exposed to weathering. On the siphonal part the spiral striation is

absent. I have not been able to discover any striæ of growth, following the direction of the radial sculpture.

In the specimen figured on Pl. XVIII, fig. 3, which I have determined as the same species on account of the perfect identity in general shape and in system of sculpture, although the spiral striation and the details of the sutural line are not visible, owing to weathering, the body chamber comprises one half of the last volution, the margin of the aperture being wanting. In the specimen figured Pl. XXIII, fig. 1, one quarter of the last volution forms part of the body chamber. The rest of my specimens are entirely chambered.

Sutures.—In the arrangement of the sutural line the species exhibits some remarkable affinities to *Flemingites glaber*, Waagen (loc. cit. Pl. XI, fig. 2, p. 188), which among the congeneric forms of the Salt Range holds a rather isolated position.

The development of the siphonal prominence is the most conspicuous character in the Salt Range species. It is almost as high as the siphonal saddle and provided on each side with a strong, rounded indentation, bordering the small central prominence, under which the siphuncle passes. These indentations, which almost take the shape of adventitious sutural elements, are followed by the deep siphonal lobe. In our species a similar development of the siphonal prominence may be observed. It can only be seen, it is true, in places where the siphonal part is perfect, and I was therefore obliged to content myself with studying the details of this arrangement at two places only in the specimens figured Pl. XVIII, fig. 2, and Pl. XXI, fig. 1.

In these two specimens the siphonal prominence takes the shape of a proper saddle reaching the same height as the siphonal saddle, and is broadly rounded above. A closer examination of its apex, however, shows that it does not form a regular arch, but that the median prominence is bordered on each side by a small, rounded indentation from which it is separated by a pointed lobule of extremely small dimensions. Both the latter and the following rounded indentation are of course much too small—they are in fact barely perceptible without a close examination—to properly merit the name of adventitious elements. Nevertheless their presence is of no slight interest, as regards the systematic position of our species which is thus shown to be closely related to *Flemingites glaber.*

The siphonal prominence, which occupies the entire breadth of the siphonal part, is followed by a deep and broad siphonal lobe, bearing about five denticulations at its base, among which those adjoining the siphonal saddle are the most prominent. But in the specimen figured Pl. XXI, fig. 1, the median ones seem to be a little longer than the rest. The principal lateral lobe is considerably deeper than it is broad, but reaches only a little further down than the siphonal lobe. Its denticulations, which occur to the number of about eight, form together an ogival arch, but reach higher up along the external (siphonal) margin. The second lateral lobe is much shorter, and provided with five to six denticulations below. The principal lateral saddle is the largest. It is bordered by parallel sides, whereas the siphonal saddle is slightly contracted at its base.

The second lateral saddle is short, very narrow, and provided with a small indentation at its base on the umbilical side. It is followed by a flatly rounded auxiliary lobe, which bears three or four strong denticulations. Outside the umbilical suture the commencement of a small saddle is visible in the largest specimen, but its greater portion is cut off by the umbilical suture.

Locality and Geological position. Number of specimens examined.—Subrobustus beds. S.E. of Muth, Spiti 2, Coll. Griesbach; Shalshal cliff near Rimkin Paiar encamping ground 1, Coll. Diener; Bambanag Cliffs, Ginthi Valley 1, Coll. Diener. The latter specimen, which is figured Pl. XVIII, fig. 3, perfectly agrees in shape and sculpture with the large one from Muth, but owing to weathering, which has obliterated the greater part of the sutures and all traces of a spiral striation, I prefer to consider it only as *Fl., cf. Rohilla.*

Remarks.—In shape, involution, and arrangement of the sutural line this species appears to be rather closely related to *Flemingites glaber*, Waagen. A distinction of the two species is easy, however. *Fl. glaber* belongs to the *semirotundati* with distinctly rounded marginal edges and a flatly rounded siphonal part and does not possess sharp marginal edges as does the Himálayan species, not even in young stages of growth. The sculpture is also different, the intervals between the radial folds being remarkably smaller than the folds themselves in *Fl. glaber*. Nor does the radial sculpture commence in the Salt Range species before a diameter of more than 30 mm. is attained by the shell. The sutural line differs especially by the stronger development of the indentations, which border the central prominence of the siphonal prominence, and by the considerably smaller size of the siphonal lobe in *Fl. glaber*. Another character of the latter species, which has not been observed in *Fl. Rohilla*, is the inequality of its concentric striation, which is not regularly distributed all over the shell, but appears stronger in some parts, and fades away in others.

Group of FLEMINGITES FLEMINGIANUS, de Kon.

3. Flemingites Salya, nov. sp. Pl. XIX, fig. 1 a, b.

Dimensions.

Diameter of the shell		257 mm.
„ „ „ umbilicus		79 „
Height of the last volution	from the umbilical suture	104 „
	„ „ preceding whorl	84 „
Thickness of the last volution		59 „
Breadth of the siphonal area		app. 17 „

This is probably the largest species of this genus which has hitherto been described. As the greater part of the body chamber is preserved in the specimen, the diameter of the latter in the full-grown state may be estimated as about 300 mm.

The species recalls *Flemingites compressus*, Waagen (Ceratite Formation, Pl. XVI, fig. 1, p. 202), in general outline and in the sculpture of the chambered portion of the shell. The whorls, however, increase a little more rapidly in height,

and the umbilicus is consequently smaller in proportion to the diameter of the entire shell.

The volutions overlap each other about two fifths of their height. The overlap of the last whorl over the penultimate one amounts to one fifth of the entire height of the former. I am sorry to say that this proportion has not been reproduced correctly in the front view of the specimen serving for description (fig. 1 b), whereas the lateral view is correct.

The transverse section of the whorls is a regular oval, if one excepts the slightly flattened siphonal part. It is nearly twice as high as broad, and consequently much more compressed than in *Fl. flemingianus*, de Kon. The largest transverse diameter is situated below the middle of the height of the volution. The lateral parts are regularly arched. Only in the immediate vicinity of the umbilical suture are they bent down in a strong curve, which meets the preceding whorl under a very steep angle. No distinct umbilical wall or edge is formed. An obtusely rounded edge corresponds to the siphonal margin. The siphonal area is comparatively broad and flatly rounded. The sculpture, which is rather faint in proportion to the size of the shell, is confined to the chambered portion of the specimen. The surface of the body chamber, it is true, is partly weather-worn to a considerable extent, but in some places, especially near the umbilical region, it is sufficiently well preserved to permit the opinion that a distinct sculpture is absent. I therefore believe that the body chamber was almost perfectly smooth.

On the chambered portion of the shell the sculpture consists of very low radial folds. They are rather narrow and separated by intervals which are but slightly broader than the folds themselves. On the inner volutions there are greater intervals between the folds, but in the vicinity of the body chamber the former are augmented in number. The inner volutions are too much weathered to allow fixing the number of folds which occur on one circuit. I can only say that they are more numerous than in *Fl. compressus*. They are all perfectly straight, and rise a little above the umbilical suture, dying out gradually near the upper portion of the lateral parts and before reaching the siphonal margin.

As the specimen is an internal cast only, the concentric striation is very indistinct and only perceptible in a few places near the siphonal area, as is indicated in the front view (fig. 1 *b*). The greater part of the body chamber is preserved, and comprises somewhat less than half of the last volution.

Sutures.—The sutural line is generally similar to that in *Fl. compressus*, but differs slightly in the development of the denticulations of the siphonal lobe and in the auxiliary series. The siphonal lobe is broad and divided by a high siphonal prominence. Its lateral branches are provided with strong indentations, among which the two adjoining the siphonal saddle are on a lower level than the rest. The denticulation, following these two indentations in the direction of the siphonal tubercle, is slightly stronger but cannot be compared in this respect to the phylloid denticulation which is developed at the base of the siphonal lobe in *Fl. compressus*. The principal lateral lobe is narrow and considerably deeper than the siphonal one. It bears six to seven

denticulations at its base, which are arranged in the shape of a narrow, pointed arch. The indentations adjoining the principal lateral saddle are the strongest. They are all sharply pointed. The second lateral lobe is at the same level as the siphonal lobe. It is much broader than the principal lateral lobe, and bears as many denticulations at its base, which are arranged in the shape of a pointed, oblique arch, the deepest indentation being shifted towards the second lateral saddle.

The siphonal and the principal lateral saddles are of similar shape, bordered by parallel margins and narrowly rounded above, but the principal lateral saddle is broader and also somewhat higher. The second lateral saddle is distinctly depressed above and slopes in a direction parallel to the umbilical suture. It is much shorter, but almost as broad as the principal lateral saddle.

The first auxiliary lobe is distinctly represented by three small denticulations, which are smaller and are on a lower level than the following higher and stronger ones. The latter, which occur to the number of three, may be considered either as rudimentary lobes and saddles or as an umbilical lobe, which cannot be dissolved into distinct elements.

Locality and Geological position. Number of specimens examined.—Subrobustus beds. S. E. of Muth (Spiti) 1, Coll. Griesbach.

Remarks.—Amongst Waagen's Salt Range species belonging to this genus we can only compare *Flemingites compressus* with our species. A distinction of the two forms is however easy. *Fl. compressus* chiefly differs by reason of its more slowly increasing whorls, a wider umbilicus, and the absence of any distinct demarcation between the siphonal area and the lateral parts. Another difference consists in the conspicuous sculpture of its body chamber, which deviates considerably from that in the chambered portion of the shell. The differences in the details of the sutural line have been mentioned above.

Nevertheless the two species are at least as closely related as *Fl. compressus* and *Fl. flemingianus*, and there can be no doubt that they belong to the same group of forms.

ISOLATED SPECIES.

4. Flemingites Guyerdeti, nov. sp. Pl. I, fig. 7.

Dimensions.

Diameter of the shell		30 mm.
„ „ „ umbilicus		11 „
Height of the last volution	from the umbilical suture	13·5 „
	„ „ preceding whorl	11·5 „
Thickness of the last volution		10 „

This species, which among its congeneric forms seems to hold a rather isolated position, is of special interest, as it is the oldest known representative of the genus, being derived from a considerably lower triassic horizon than the Ceratite Sandstone, from which all the Salt Range species are derived. The species recalls in general shape *Danubites trapezoidalis*, Waagen (Ceratite Formation, Pl. XXI,

fig. 3, p. 76), especially owing to its conspicuous transverse section. This species seems to have attained small dimensions only, the specimen under description being already provided with a body chamber, the posterior termination of which corresponds to a diameter of 26 mm. The involution is inconsiderable, the whorls overlapping each other a little more than one third of their height. The overlap of the last volution over the preceding one amounts only to about one seventh of the entire height of the former.

The transverse section is very characteristic, nearly square, higher than broad. Although the siphonal part does not represent the largest transverse diameter of the whorls, its breadth is but very little smaller. The lateral parts are almost perfectly flat. They pass into the siphonal part and the umbilical suture in a strongly bent curve, and neither marginal nor umbilical edge exists. The siphonal part is flatly rounded. The elevation of the lateral parts above the umbilical suture is comparatively great. The umbilicus itself appears less shallow than in most of the congeneric species.

There is no trace of a radial sculpture, but the spiral sculpture is most distinctly developed. As a great part of the shell is preserved I have been able to examine it in detail. On the internal cast the spiral striation is but very faint, but is distributed all over the surface of the shell with much regularity. The striation is very faint and considerably weaker on the siphonal area than on the rest of the shell. Under the lens the spiral striæ appear to be low parallel ridges of unequal strength, and the strongest among them are met with near the siphonal margin, but even here more delicate ones are always intercalated between them. One of these stronger striations is of special interest. It is situated exactly at the point which represents the siphonal margin; observed under a magnifying glass this striation appears as a row of longitudinal, flat beads. Identically the same character of striation was described in *Sturia Sansovinii*, v. Mojs., by F. v. Hauer,[1] who described the delicate secondary striations which follow the median line of each furrow in the lower portion of the lateral parts, as consisting of a series of very delicate beds. A similar character of these secondary striations was noticed by myself in the Himálayan specimen of *Sturia Sansovinii* from the Muschelkalk of the Shalshal Cliff.[2] It is rather unfortunate that this character cannot be reproduced in the illustration.

The last septum is situated about 10 mm. from the anterior termination of the siphonal part in our specimen. But as a considerably larger portion of the shell near the umbilical region has been preserved, and its continuation may be made out by the presence of an elevated ridge, following the direction of the umbilical suture, a little more than one half a volution at least must have belonged to the body chamber. This fact leads to the conclusion that our specimen must be considered most probably as a full-grown individual, in spite of its comparatively small dimensions.

[1] *F. v. Hauer*, Die cephalopoden des bosnischen Muschelkalkes von Han Bulog bei Sarajevo, Denkschr. kais. Akad. Wiss. Wien, math. nat. Cl., LIV, Abth. I, 1887, p. 46.
[2] Cephalopoda of the Muschelkalk, Pl. XV.

Sutures.—The sutural line is rather simple. The siphonal lobe does not exhibit a trace of adventitious elements and the auxiliary series consists of one single lobe only, which is cut off by the umbilical suture.

The siphonal lobe is very short, and is at a higher level than any of the others and is divided by a small siphonal prominence, the marginal sides of which strongly converge towards the siphonal channel. Each of the lateral branches of the siphonal lobe is bifid. The principal lateral lobe is very deep, broad and strongly serrated at its base. The denticulations of the two lateral lobes are arranged in shape of regular arches.

The siphonal saddle much exceeds the two lateral ones in size. All the saddles have parallel sides and are broadly rounded above. The auxiliary lobe is very small and is on the same level as the second lateral lobe.

Locality and Geological position. Number of specimens examined.—Otoceras beds. S.E. of Muth, Spiti 1, Coll. Griesbach.

Remarks.—This species differs so considerably from the congeneric forms by its transverse section, deeper umbilicus, the absence of any radial sculpture, and the details of the sutural line, especially by the short and narrow siphonal lobe, that it is impossible to compare it with any of them.

I am consequently obliged to treat it as an isolated form, which is not only the most primitive but also the geologically oldest of the genus *Flemingites*.

Genus: OPHICERAS, Griesb., emend. Diener.

1880, *Ophiceras*. Griesbach, Rec. Geol. Surv. Ind., XIII, 109.

The forms, which will be described in the following pages under the generic designation, proposed by C. L. Griesbach, surpass enormously, in number of individuals, all the other members of the Cephalopoda, which are contained in the geologically oldest strata of trias of the Himálayas, *viz.*, the Otoceras beds. All these forms appear at first sight to be linked together most intimately by similarity of shape and sutural lines. Groups of forms, it is true, may be distinguished among them, without great difficulty, which owing to remarkable characters seem to constitute excellent species, but a closer examination most conclusively shows that even groups, the typical forms of which seem to be widely different, are connected by transitional forms with such indifferent characters, that it is scarcely possible to identify them with either the one or the other species.

This observation on the species, which necessarily must be distinguished among the large number of allied forms, applies also to the genus itself. It is especially the genus *Meekoceras*[1] from which it is so vaguely separated that, with the exception of Griesbach, almost all the later authors, who treated on this subject, have either united the two, or if any, as for instance Waagen, considered *Ophiceras* to be a proper genus, he did so on the supposition of an adventitious lobe, which does not exist in

[1] The genus *Meekoceras* is taken here in the sense only which will be defined later on.

reality. Although I hope to justify my view, that *Ophiceras* is indeed a proper genus and has been correctly proposed by Griesbach as such, I am obliged to confess that the most important characters of *Ophiceras* are of such a nature that they can only be observed in perfectly well preserved specimens, of which there are many in the rich collection from the Himálayan Otoceras beds.

The genus *Ophiceras* was proposed in 1880 by Griesbach to embrace three forms from the Himálayan lower trias, *Ophiceras tibeticum*, which has to be considered as prototype of the genus *O. medium* and *Ophiceras* (*Danubites*, mihi) *himalayanum*. In their external appearance and in the arrangement of their sutural line these forms exhibit such a close similarity to the genus *Xenodiscus*, which had then been just introduced by Waagen, that E. v. Mojsisovics did not hesitate to declare the two to be synonymous.[1] This view he still maintained in 1886, in his Memoir on the triassic faunæ of the Arctic regions, when he removed *Ophiceras himalayanum* and *Xenodiscus plicatus*, Waag., from their respective genera and placed them among his group of the *Ceratites obsoleti*.[2]

As has been shown in the introduction to *Xenaspis*, it was demonstrated later on by Waagen,[3] that the generic designation *Xenodiscus* must remain for *X. plicatus*, which is distinguished from the *Ceratitidæ* by its longer body chamber. He consequently united the triassic forms, which had hitherto been confounded with *Xenodiscus* as a new genus, *Gyronites*, which in my opinion is, at least partly, identical with *Meekoceras*, Hyatt. To this genus he attributes, although with great reservation, *Ophiceras himalayanum* and *O. medium*, but considers *O. tibeticum* as the type of an independent genus, to which the name *Ophiceras* ought to remain and which probably would form part of the *Gymnitinæ*. According to him, a close relation seems to exist between *O. tibeticum* and the genus *Xenaspis* owing to the sculpture, but the cross section of the whorls is different. A special stress is laid on the supposed existence of an adventitious lobe.

The examination of more than thirty specimens of *Ophiceras tibeticum* from my own and Griesbach's collections has convinced me, that in this species as well as in all the rest of the genus an adventitious lobe is decidedly absent. Waagen was led into his error by a misinterpretation of Griesbach's figure Pl. III, fig. 6a. In this figure the broad siphonal hole or funnel, under which the siphuncle passes, is represented in a manner which caused Waagen to take the siphuncle hole for the siphonal lobe and to consider consequently the prominence of the siphuncle as an adventitious saddle. Griesbach's description is, however, quite correct. He speaks of the siphonal lobe being much wider than high, with a moderately high siphonal saddle, separated by the siphuncle.[4] There is no doubt that Griesbach would have noticed an adventitious lobe in his description, if any such had been present, but it must be

[1] *E. v. Mojsisovics.* Die Cephalopoden der Mediterranen Triasprovinz. Abhandlgn. k. k. geol. Richs-Anst. X, Bd. 1882, p. 232.

[2] Arktische Triasfaunen, l. c., p. 74.

[3] *W. Waagen*, Pal. Indica, ser. xiii, II, Fossils from the Ceratite Formation, pp. 161, 209.

[4] In Griesbach's descriptions the siphonal prominence is meant by the expression siphonal saddle, whereas the saddle, which in my memoirs is called siphonal saddle, is distinguished by him as the "external" saddle.

confessed that from his drawing its presence might be easily supposed, if one had not the opportunity of comparing it with Griesbach's type specimen.

With the absence of the supposed adventitious lobe Waagen's strongest argument in favour of an independent generic position of *Ophiceras* falls to the ground. Nor is the difference in sculpture between *O. medium* and *O. tibeticum* in reality such a striking one as might be supposed by comparing the most typical forms of the two species only. When describing the species I shall have ample opportunity of demonstrating the wide range of variety which is peculiar to the forms of this genus, and it will become evident that the mode of sculpture in *O. tibeticum*, although very remarkable, can scarcely be considered as a sufficiently distinct character to entitle us to place *Ophiceras* among the *Gymnitinæ*, and we shall see that the supposed similarity to *Xenaspis* is not a very striking one.

While working on the Himálayan materials a very remarkable character has been discovered, which is common to the smooth forms (*O. medium*), as well as to the sculptured ones (*O. tibeticum*), and confirms the correctness of Waagen's view regarding the systematic position of the genus. This character consists in the presence of a distinct delicate concentric striation, which is restricted almost exclusively to the internal casts, and is either quite absent or very indistinct on the surface of the shell. It consequently appears to be a character which is peculiar to the innermost layer of the shell during the life of the individual, to the so-called "mother-of-pearl-layer" (Perlmutterschicht). A similar concentric-striation, confined to the innermost layer of the shell, has so far never been described in any triassic ammonite. The spiral striation itself, however, strongly recalls the genus *Flemingites*. Owing to it *Ophiceras* differs decidedly from the *Meekoceratidæ* and is brought into close affinity with the *Gymnitinæ*.

The delicate spiral striation is found in very few specimens sufficiently well preserved to be seen distributed regularly all over the cast, as is the case in the specimen of *Ophiceras Sakuntala*, figured Pl. X, fig. 4*a*, or in that of *O. serpentinum*, figured Pl. X, fig. 7. But traces of it may be observed in all specimens, specially in the vicinity of the umbilical region or in the siphonal part. The only exception, in which this has not been the case, is *Ophiceras Dharma*, of which species two specimens only exist, but I have united this species with the genus on account of the similarity in shape and sculpture with *O. demissum*, Oppel, and of the presence of an elevated spiral ridge in the middle of the lateral parts, which strongly recalls the same character in several forms of *Gymnites*.

Although the presence of a spiral striation is certainly a character of no small importance, connecting as it does *Ophiceras* with *Flemingites* or *Sturia*, but removing it from the *Meekoceratidæ*, it is unfortunately rarely seen well, owing to weathering. Among the collections made in the Ussuri district by the Russian Mining Engineer D. L. Iwanow, there are a few specimens, which in all their characters agree perfectly with *O. Sakuntala*, but as the matrix, in which they are found, is a sandstone, it is perfectly hopeless to look for so delicate characters, as the spiral striation of the cast, peculiar to the Himálayan *O. Sakuntala*. Neverthe-

less in this case a determination is comparatively easy, because one has to deal with a well-known species, the systematic position of which is safely established. But a decision becomes much more difficult, or even impossible, when dealing with partly weather-worn casts, as is the case in most species of Waagen's genus *Gyronites* from the lower Ceratite limestone of the Salt Range. From the description of *Ophiceras Sakuntala* it will be seen that a Salt Range species, *Gyronites vermiformis*, Waagen, is very similar to some forms of the former species. And in this case the spiral striations of the cast are the only means of deciding the question whether the Salt Range species belongs to *Meekoceras* or to *Ophiceras*. The state of preservation of the single specimen, described by Waagen, is such that spiral striations even if formerly present could not be observed. Although this as several other species of *Gyronites* might perhaps belong to *Ophiceras*, I have absolutely failed to find out any trustworthy proofs for such a conclusion.

Another instance is *Xenodiscus Karpinskyi*, v. Mojsisovics (Arktische Triasfaunen, Pl. XI, fig. 13, p. 75). The similarity with *Ophiceras Chamunda* is most striking. But the specimen, described by E. v. Mojsisovics, was provided with its entire shell and no spiral striation could consequently have been noticed, even if it had been present in the cast. I much question whether I ought to attribute this species to *Ophiceras* or to *Meekoceras*.

In a third instance the difficulty is still greater. Amongst the fauna of the Meekoceras beds of Idaho, described by C. A. White in the Twelfth Annual Report of the U. S. Geological and Geographical Survey of the territories for the year 1878 (Washington, 1883), a species is figured, on Pl. XXXI, fig. 1.c., which has been erroneously united with *Meekoceras aplanatum* by the American palæontologist, but it differs from this species by its numerous volutions, which scarcely overlap each other. This species was renamed by Waagen as *Gyronites whiteanus*, but it exhibits a most striking similarity to *O. Dharma* in its general shape. It is, however, impossible to decide whether it really ought to be placed into the genus *Ophiceras* or better remain among the *Meekoceratidæ*, or whether it ought to be removed from the *Ammonea leiostraca* altogether, on account of its sculpture, in which case it should be transferred to the *Danubites obsoleti*.

Thus I can only point out the possibility that among the Arctic, American and Salt Range forms which are commonly attributed to *Meekoceras* or to one of its subgenera, representatives of the genus *Ophiceras* may be present. I must, however, abstain from deciding this question and content myself with the conclusion that the Himálayan species of *Ophiceras*, as shown in the following chapter, certainly correspond to a natural group of forms, which are different from the *Meekoceratidæ* and bear the closest affinity with the *Gymnitinæ*.

That the character by which their generic independence from *Meekoceras* can be proved is only accessible with difficulty, depending as it does on the state of preservation of the specimen, cannot be admitted as a sufficient argument against its use as foundation for a generic distinction, since it can be shown to hold good in all Himálayan species.

The genus *Ophiceras*, as defined in the manner shown, is restricted in the Himálayas entirely to the lowest division of the trias, the Otoceras beds. No species is known from the subrobustus beds, whereas in the Otoceras beds some of them far predominate over all the rest of the cephalopoda by their number of individuals. Especially *O. Sakuntala* forms entire layers of shells in the Otoceras beds of the Shalshal Cliff.

In all species, belonging to this genus, the sutural line is very simple. The siphonal lobe is as a rule broad, and divided by a tolerably large siphonal prominence which is very often provided with a distinct median depression, below which the siphuncle passes. There are always two lateral lobes present, which are serrated at their base. The auxiliary series consists, as a rule, either of a short auxiliary lobe or of a row of small denticulations forming a straight line on a flatly rounded arch. Only in *Oph. tibeticum*, which seems to be the highest developed form among its congeneric species, a distinctly individualised auxiliary lobe is followed by an auxiliary saddle, which stands partly outside the umbilical suture.

The margin of the aperture has been observed in a tolerably large number of specimens of *Ophiceras medium* (Pl. IX, fig. 1), *O. Sakuntala* (Pl. X, fig. 3, 4), *O. gibbosum* (Pl. IX, fig. F), *O. ptychodes* (Pl. XI, fig. 3, 6), *O. serpentinum* (Pl. XIII, fig. 5), *O. demissum* (Pl. XIV, fig. 2). In none of my specimens does the length of the body chamber surpass one half volution by more than the twelfth part of its entire circumference. This is exactly the length of the body chamber in *Meekoceras*, and it is considerably shorter than in *Xenaspis*.

The genus *Ophiceras* is represented in the Himálayas by ten species, which may most conveniently be arranged in groups according to the differences in sculpture. One group of forms, which is closely allied to *O. tibeticum*, Griesbach, is distinguished by a sculpture, which consists of strong falciform folds and knob-like elevations, but which are not as distinctly demarcated as the tubercles in the *Trachyostraca*. In the other group the surface of the shell is either perfectly smooth or covered with low and broad falciform folds. This group is named from the most common species of the genus *O. Sakuntala*. It must be borne in mind, however, that a distinct boundary does not exist between the two groups, and that, even in species with a strongly developed sculpture, transitional forms occur, which point to the most intimate connection of the different varieties, among which the most prominent ones have been singled out as prototypes of my species.

We arrive thus at the following classification of the species which belong to the genus *Ophiceras* :—

I. Section.

GROUP OF OPHICERAS TIBETICUM, Griesb.

1. *Ophiceras tibeticum*, Griesbach.
2. *O. gibbosum*, Griesb.
3. *O. serpentinum* nov. sp.
4. *O. platyspira* nov. sp.

II. Section.

Group of Ophiceras Sakuntala, Dien.

5. *Ophiceras Sakuntala* nov. sp.
6. *O. medium*, Griesb.
7. *O. ptychodes* nov. sp.
8. *O demissum*, Oppel.
9. *O. Chamunda* nov. sp.
10. *O. Dharma* nov. sp.

Among these ten species the *biangulares* (in the sense of Waagen) and the *semirotundati* are represented each by one single species only (*O. Dharma*, viz., *O. platyspira*), whereas all the rest are *rotundati*.

Group of OPHICERAS TIBETICUM, Griesb.

1. Ophiceras tibeticum, Griesbach, Pl. VIII, fig. 1—7.

1880. *Ophiceras tibeticum*, Griesbach, Palæontological Notes on the Lower Trias of the Himálayas, Rec. Geol. Surv. Ind. XIII, 109, Pl. III, fig. 1—7.

1895. *Ophiceras tibeticum*, Waagen, Salt Range fossils, Pal. Indica, ser. xiii, II, Fossils from the Ceratite formation, p. 209.

Dimensions.

	fig. 1.	fig. 5.
Diameter of the shell	?	71 mm.
" " " umbilicus	app. 33 mm.	33 "
Height of the last volution from the umbilical suture	21·5 "	24 "
Height of the last volution from the preceding whorl	16 "	18 "
Thickness of the last volution	15 "	20·5 "

Griesbach himself has considered *Ophiceras tibeticum* to be the prototype of the genus, and among its congeneric species it is certainly the only one, which has attained, comparatively speaking, the most advanced stage of development. As in all species of *Ophiceras*, the range of its variation is somewhat wide. Consequently I shall, in this as in the following descriptions, begin with the typical form, and afterwards proceed to its varieties.

Typical form.—As such, I consider the two most complete specimens, figured by Griesbach, Pl. III, figs. 4, 5, especially the first, which is reproduced in my Memoir, Pl. VIII, fig. 1.

The general shape is disciform, with numerous, very involute, whorls which overlap each other a little more than one-third of their height. The transverse section of the volutions is cardiform or lanceolate. The largest transverse diameter corresponds exactly to the umbilical margin. From this point the lateral parts converge decidedly towards the siphonal part, forming perfectly flat planes, which pass into the rounded siphonal part in a strongly bent curve, corresponding with the siphonal margin. The umbilical margin is more distinctly defined. It forms a distinct edge in the inner volutions, whereas it is obtusely rounded in the outer ones;

the umbilical wall is comparatively high and steep, but never vertical. The umbilicus is very large and appears rather shallow.

The characteristic sculpture has been very well described by Griesbach. It consists of narrow folds or wrinkles, which alternate at irregular intervals with rounded bumps, largest near the umbilical region, and slightly elongated towards the middle portion of the lateral parts. The sculpture of the shell corresponds perfectly to that seen in the internal cast. Its falciform wrinkles, or growth lines, are turned backwards on the umbilical wall. On the lower portion of the lateral parts they describe a crescent shaped curve, convex forwards, and near the siphonal margin a second slighter curve, with its convexity turned backward. Only in the immediate vicinity of the siphonal margin are the wrinkles turned forward, and they keep this direction in crossing the siphonal part.

In one specimen, however, figured Pl. VIII, fig. 3a, the lines of growth cross the siphonal part in a straight direction, and this strange character recalls geologically older types, in which the lines of growth are turned backwards in the siphonal area.

Range of variation.—Several variations of this typical form, both in outward shape and sculpture, have been observed, which are most intimately connected among each other by transitions. One of the most remarkable variations is represented by the specimens figured Pl. VIII, figs. 5 and 6. In these specimens the number of volutions within the umbilicus is considerably smaller than in the typical form, corresponding to an equal diameter, and the volutions themselves consequently increase more rapidly in height. The umbilical edge is also less distinct and even completely rounded off in the last volution. The umbilicus is less shallow, the umbilical wall higher and the transverse section decidedly broader. An extreme instance of this character is represented by the fragment, figured Pl. VIII, fig. 3, in which the height and thickness of the last volution attain nearly equal dimensions, their respective dimensions being 21·5 and 20 mm. The representatives of this variety with thick whorls are, at the same time, distinguished by a more broadly rounded siphonal and by less strongly converging lateral parts. In the typical form this shape of the transverse section is peculiar to the innermost volutions, whereas in the variety it persists in later stages of growth.

The range of variation of the sculpture is scarcely less considerable. There are specimens, in which the number of bumps and stronger wrinkles is nearly equal (Pl. VIII, fig. 6). In some specimens several wrinkles originate in one of the bumps. The distribution of these two sculptural elements is, however, quite irregular. There is absolutely no rule as to the predominance of the bumps in the inner volutions or in the last whorl. The wrinkle, or narrow folds, seem to be the more important elements in the sculpture, because they are always present, even in specimens in which no trace of bumps are visible. In the body chamber, especially, the bumps are frequently absent. In this case the sculpture consists either of very numerous, rounded folds, which are confined to the vicinity of the umbilical region (Pl. VIII

fig. 4) or of more distant narrow folds, running over the lateral parts and intermingled with numerous, very delicate lines of growth, which fill the intervals between them. There are forms in which the sculpture becomes quite indistinct and is entirely restricted to the inner volutions, as, for instance, in the specimen figured Pl. VIII, fig. 2, which on account of their general characters must nevertheless be placed among this species.

The spiral striation of the cast has only been observed in the specimens figured Pl. VIII, figs. 5 and 6, near the umbilical region. This concentric striation of the cast is not to be confounded with the epidermidæ, which are well developed in the siphonal area of the first-mentioned specimen. These epidermidæ consists of very delicate interrupted wrinkles, which cross the radially directed growth lines at right-angles. They only extend as far as the siphonal part, which had formerly been covered by the body chamber portion of the last volution.

The length of the body chamber is not exactly known, the margin of the aperture not having been preserved in any of the specimens. The fragments of the last volution, figured on Pl. VIII, figs. 3, 4, 7, represent portions of the body chamber only, whereas the specimens, figured on Pl. VIII, figs. 5, 6, are almost entirely chambered. In the specimen fig. 2 the fragment of the outer volution forms part of the body chamber.

Sutures.—The sutural line of this species is completely known. It was correctly figured by Griesbach, omitting his reproduction of the siphonal prominence, which gave rise to some misunderstanding, as was pointed out in the introductory remarks.

The siphonal lobe is broad and short and provided with a siphonal prominence of varying height. As a rule it is but little more than half as high as the siphonal saddle, but in exceptional cases (fig. 5*c*) it comes very near to the latter. Its sides always strongly converge, and, in its centre, it is indented by a small incision, marking the siphonal hole or funnel, which is comparatively broad. The lateral branches of the siphonal saddle are provided with a varying number of denticulations at their base. Their terminations are bi-, tri-, or even quadri-cuspidate and the number of indentations increases as a rule in one and the same specimen, the nearer one approaches to the last septum. A single pointed termination has, however, not been observed in any of my specimens.

From the principal lateral lobe, which is the deepest, the lobes gradually ascend towards the umbilical suture. All have parallel sides and are serrated at their base. The principal lateral saddle is the largest, but the lobes and saddles vary to a certain extent in their height and breadth.

In the inner volutions the second lateral saddle is followed by a serrated auxiliary lobe, which is cut off by the umbilical suture. In the last volution of one of my specimens, however, (Pl. VIII, fig. 5), the commencement of an auxiliary saddle is distinctly visible outside the umbilical suture. This saddle is followed immediately by the deep bipartite antisiphonal lobe on the internal side of the volution.

As regards the range of variation, which the shape of the sutural elements

undergoes in this species, it needs only a glance at Griesbach's figures to get an idea of the two extreme cases (loc. cit. Pl. III, figs. 6a and 7). But it would be of no use to describe them in detail, as actually no two specimens with quite identical sutures are found.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 6, Coll. Griesbach, 7, Coll. Diener; Kiunglung encamping ground, 15, Coll. Griesbach, 1, Coll. Diener; Hills above Kuling (Spiti), 2, Coll. Griesbach; Khar, Spiti, 3, Coll. Griesbach.

One of Griesbach's specimens from the Shalshal Cliff, was found in the topmost beds of the Otoceras stage, 25 feet above the main layer of *Otoceras Woodwardi* bed 70, Griesbach's section).

2. Ophiceras gibbosum, Griesbach, Pl. IX, figs. 4, 5, 6, 7.

1880. *Trachyceras* (?) *gibbosum*, Griesbach, Palæontological Notes on the Lower Trias of the Himálayas Rec. Geol. Sur. Ind., XIII, Pl. III, fig. 10, p. 111.

Dimensions.

	Fig. 4.	Fig. 6	Fig 7
Diameter of the shell	50 mm.	45 mm.	73 mm.
" " " umbilicus	17·5 "	16 "	27 "
Height of the last volution { from the umbilical suture	18 "	17 "	27 "
Height of the last volution { " " preceding whorl	14 "	12 "	21 "
Thickness of the last volution	14 "	12 "	18 "

Although Griesbach has placed this species among *Trachyceras* on account of a distinct resemblance of its outlines with *Ceratites semipartitus*, v. Buch, he remarks in his description that it may probably represent a connecting link between *Ophiceras* and *Xenodiscus*, Waag. There is indeed no reason to separate the present species from the genus *Ophiceras*, as it is closely allied to *O. tibeticum*, and differing only by its conspicuous sculpture.

Typical form. As typical form the one represented by Griesbach's type specimen (Pl. IX, fig. 4) is to be considered. In general shape and in volution it recalls the variety of *O. tibeticum*, with less numerous and more rapidly increasing whorls. The volutions overlap each other to but little less than one half of their entire height. The transverse section is lanceolate, but the largest transverse diameter is situated above the umbilical margin. The shape of the upper portion of the transverse section is the same as in the typical form of *O. tibeticum*. The lower portion, however, differs considerably by the complete absence of any distinct demarcation between the lateral parts and the umbilical wall. The umbilical margin is not distinctly marked, the lateral parts joining the obliquely inclined umbilical wall in a very gradual curve.

The sculpture consists of broad bumps which are arranged along the median region of the lateral parts and are of very regular outline. They are comparatively flat, and their elevation is small in proportion to their diameter. There are four in the preserved portion of the last volution, but they are only distinct on one side of the

shell, whereas but very faint indications of bumps are observed on the other. The inner volutions are almost smooth, but a few very broad and flat depressions show that a similar system of sculpture seems to be present there also. In addition to these bumps, delicate wrinkles crossing the siphonal side may be observed.

Range of variation.—Some of the specimens differ from the typical form by a greater height of the transverse section and compressed whorls. The sculpture varies much more than the outward shape of the shell. The bumps occur quite irregularly, nor is their shape of the same character in all the specimens. As a rule they are much stronger than in *Oph. tibeticum* and stand at a short distance only from each other in twos or threes, which are separated from the next by a larger interval. They frequently assume the shape of elongated, thick folds. In the specimen fig. 3 two thick S-shaped bumps are very strongly developed in the middle portion of the body chamber, whereas the rest is of quite insignificant strength. A similar arrangement may be observed in the specimen fig. 5, which has two thick bumps, divided by a deep and narrow depression. In the specimen figured Pl. IX, fig. 6*a*, the last two bumps are united near the umbilical margin into a broad swelling. Distinct folds occur with the bumps, as in *Ophiceras tibeticum*, corresponding in direction with the growth-lines of the shell. In the largest specimen (fig. 7.) the bumps are very flat and elongated. The shallow depressions between them are consequently more conspicuous. This specimen represents a transition to forms, which are almost perfectly smooth or exhibit only faint traces of bumps, but must still be placed amongst these species on account of their general shape and the outlines of their transverse sections.

The surface sculpture of the shell is identical with that of *O. tibeticum*, but the numerous delicate growth lines are always decidedly bent forward near the siphonal margin.

The concentric, spiral striations of the cast have been observed in most of the specimens. It is especially distinct in the vicinity of the umbilicus of the specimen fig. 7, but well developed also in Griesbach's type specimen. In the latter, a spiral line is very distinct, which, following the centre line of the sides, forms a low ridge, as it is frequently observed in full grown individuals of *Gymnites*, such as *Gymnites jollyanus* Oppel (Cephalopoda of the Muschelkalk, Pl. XII, fig. 1).

In one of the specimens (Pl. IX, fig. 7) the margin of the aperture is partly preserved. Its outline follows in general the direction of the folds and lines of growth, but is not strictly parallel to the latter. On the whole it is less strongly falciform, and not turned backward in the vicinity of the umbilical suture. The margin of the aperture is preceded by a distinct contraction of the shell, which is rounded off regularly. In this specimen the length of the body chamber comprises exactly one half of a volution.

Sutures.—The sutures are very similar to those of the preceding species, but there is no trace visible of an auxiliary saddle in any of the specimen. The sutures vary considerably. The siphonal lobe is divided by a siphonal prominence, the top

of which is distinctly indented by a central notch. The branches of the siphonal lobe terminate either in a single sharp point (fig. 6c) or are denticulated at their base. The auxiliary lobe and the second lateral lobe frequently form an obliquely sloping arch (figs. 6c, 7c). The antisiphonal lobe is bicuspidate.

A comparison of the sutures of different specimens, as shown in the figures of Pl. IX, will better demonstrate the extent to which the sutural line is subject to variation, than any description could do.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar, encamping ground, 5, Coll. Griesbach, 5, Coll. Diener.

Remarks.—The typical form of this species may be easily recognized by its remarkable sculpture. It may be distinguished from the smooth variety of *O. tibeticum* with few and thicker whorls, by the absence of a distinct umbilical margin. There are forms transitional with *O. Sakuntala*, which will be treated later on in the text.

3. Ophiceras serpentinum, nov. sp., Pl. XIII, figs. 1—7.

Dimensions.

	Fig. 2.	Fig. 5.	Fig. 7.
Diameter of the shell	86 mm.	67 mm.	65 mm.
" " umbilicus	40 "	30 "	25 "
Diameter of the shell } at the place of	65 "	app. 50 "	36 "
" " umbilicus } its greatest aplanation	28 "	21 "	13·5 "
Height of the last volution { from the umbilical suture	28 "	22 "	28 "
Height of the last volution { " " preceding whorl	23 "	18 "	20 "
Thickness of the last volution	23 "	15 "	16 "
Height { of the last whorl at the place	21 "	17·6 "	16 "
Thickness { of its greatest aplanation	16·5 "	15 "	16 "

This species may be roughly described as an elliptical variety of *Ophiceras tibeticum*, although the range of its variation is still wider, and forms must be included in this species, which, like the one figured Pl. XIII, fig. 7, look rather different from the typical *Ophiceras tibeticum*.

Typical form.—As such I consider the specimens figs. 2, 5, which are very closely allied to the typical form of *O. tibeticum* from which they differ specially by their obliquely elliptical outlines. The numerous whorls leave a wide and shallow umbilicus open. The involution is identical with that of the species named, but the amount of the overlap of the volutions is smaller at the place of their greatest aplanation.

The transverse section is cardiform and the largest transverse diameter corresponds exactly with the umbilical margin. The lateral parts do not converge so strongly as in the typical species of *Ophiceras tibeticum* and are slightly arched. The siphonal area is rounded and passes gradually into the lateral parts. The height of the volutions is considerably larger than their thickness, at least in full grown individuals. The whorls increase quite regularly in these two directions and are not

much thicker at the place of their greatest aplanation. The umbilical margin is always well defined in the inner volutions, as in *Oph. tibeticum*, but is gradually rounded off in the last volution.

The sculpture consists of bumps and folds of irregular strength. As a rule the bumps predominate on the inner volutions and are replaced by folds of a falciform shape on the last whorl. The direction of the folds is exactly the same as described in *O. tibeticum.*

Range of variation.—In this species, as in *O. tibeticum*, a variety with less numerous volutions and with a comparatively smaller and deeper umbilicus is known to me (Pl. XIII, figs. 3, 4, 6, 7). It is distinguished by considerably thicker whorls, the thickness of which changes in proportion to their height, in such a manner that the largest transverse diameter corresponds regularly to the points of greatest aplanation of the shell. For instance in the last volution of the specimen fig. 4, the respective measurements in millimetres are as follows :—

	Longitudinal axis.		Transverse axis.	
Height of the transverse section	15·5	22	15	20·5
Thickness of the transverse section	12·5	18	15	20·5

In the body chamber of some of my specimens of this variety, another remarkable character may be observed, which differs from the typical form. It is a conspicuous change in the shape of the transverse section altogether. Not only have all traces of a distinct umbilical margin completely disappeared, but even the lanceolate outline of the cross section has become perfectly obscured (figs. 6b, 7b). The section is almost oval, the lateral parts are distinctly arched, and the siphonal part appears to be very broadly rounded. And yet in the same specimens the transverse section is quite identical with that of the typical form as far as the commencement of the last volution. That this change of its shape in the body chamber portion of the volutions is not a general character of this species is clearly shown from fig. 5b, the cross section preserving its original shape as far as the margin of the aperture. Specimen fig. 7 presents an extreme type of this variety, but there are many transitional forms from this to the typical one.

The range of variation in the sculpture is about the same as in *O. tibeticum*, from specimens with strong bumps and folds to such as are nearly smooth (figs. 3, 7). In specimen fig. 4 a similar sculpture may be observed as in the body chamber of *O. tibeticum* figured by Griesbach, Pl. III, fig. 1 (reproduced in this Memoir, Pl. VIII, fig. 4). This system of sculpture, consisting of numerous rounded folds with very narrow intervals between them, alternates in the last volution with the regular, broad S-shaped folds.

The shell is well preserved in several specimens and exhibits the numerous delicate growth lines, which follow the direction of the folds. They are frequently arranged into bundles and more strongly developed on the surface of the folds than in the intervals, which are free from sculpture. In figs. 2a and 4 this character is fairly well reproduced.

The spiral striation of the cast is perfectly preserved in the specimen fig. 7. In the body chamber portion the concentric striations are seen nearly all over the lateral parts as far as the siphonal margin. Under the lens the striations appear as very low, but comparatively broad ridges, the more delicate ones being but very faintly indicated. None of the specimens show traces of a similar striation on the shell, even if the lines of growth are well preserved.

The margin of the aperture is seen in the type specimen fig. 5a. It is of a similar shape as in *O. gibbosum*, Griesb., following in general the outlines of the lines of growth. But whereas these are strongly bent backward near the umbilical wall, the apertural margin runs in a straight, radial direction towards the umbilical margin. Nor is its curve on the lateral parts so strongly falciform, as in the growth lines. Near the siphonal area it is slightly turned forward.

The body chamber comprises almost exactly one half a volution in length in this specimen. In the specimens figs. 3, 6 and 7 one half of the last volution forms part of the body chamber, the margin of the aperture not being preserved. The specimens figs. 2 and 4 consist of air chambers only.

Sutures.—In their general arrangement the sutures are similar to those of *O. gibbosum.* In the details of their shape they vary to a rather large extent, as may be seen from the figs. 3b and 2b, in which two extreme types are represented.

The saddles are very broad and short in the sutural line of the first specimen (fig. 3) separated by narrow lobes; in the second specimen (fig. 2) both the lobes and saddles are narrow and elongated. But even in one and the same specimen, these two different characters of the sutural elements are represented. The saddles are broader and shorter in those portions of the whorls, which are situated nearer to the longitudinal axis of the shell, whereas they are longer and narrower at the place of the greatest aplanation.

The siphonal lobe is always comparatively short, and its terminal branches are denticulated. The lobe line ascends from the principal lateral lobe towards the auxiliary lobe. The saddles are frequently depressed above, their external portion being cut off obliquely. The auxiliary lobe forms a straight, serrated line, ascending towards the umbilical suture.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Kiunglung encamping ground, S. of Niti Pass, 18, Coll. Griesbach; 19, Coll. Diener; Shalshal Cliff near Rimkin Paiar encamping ground, 1, Coll. Diener; Khar (Spiti) 2, Coll. Griesbach.

Remarks.—It is one of the best characterized species of this genus. Although transitional forms to *Oph. tibeticum* are known to me, in which the obliquely elliptical outline gradually approaches the normal spiral, I have never been at a loss to distinguish the two species, if larger specimens were at my disposal, in which the rounded off umbilical margin and the arched lateral parts form good characters. The specimen figured Pl. XII, fig. 1, is an instance of the transitional forms in which the outline approaches the normal spiral.

Transitional forms exist also to the following species, which will be discussed later on.

4. Ophiceras platyspira nov. sp., Pl. XII, fig. 5, 6.

Dimensions.

	Fig. 5.	Fig. 6.
Diameter of the shell	79 mm.	58 mm.
" " " umbilicus	30 "	22·5 "
" " " shell } at the place of its greatest splanation	app. 67 "	30·5 "
" " " umbilicus } at the place of its greatest splanation	29 "	16 "
Height of the last volution from the umbilical suture	29 "	21 "
" " " " " preceding whorl	24 "	17 "
Thickness of the last volution	15 "	14 "
Height of the last whorl } at the place of its greatest splanation	18 "	15·5 "
Thickness " " " " } at the place of its greatest splanation	13 "	12 "

The typical form of this comparatively rare species is closely allied to *Ophiceras serpentinum*, from which it differs by the persistence of its distinct umbilical margin in later stages of growth, by flat lateral parts and by a very flatly rounded siphonal area, which is separated from the sides by an obtusely rounded off siphonal edge.

The umbilicus is wide and very shallow. The whorls overlap each other less than one third of their height. Although the largest transverse diameter coincides with the umbilical margin, the thickness of the cross section is not much reduced in its immediate vicinity. The height of the volutions is always much greater than their thickness, and I do not know a variety of this species with thick whorls. The lateral parts are quite flat and converge more slowly than in any one of the species already described. The siphonal margin is rounded off and is well defined even in the immediate vicinity of the apertural margin, but it is most sharply marked in the inner volutions, where in some of the specimens it is in the shape of a distinct, obtusely rounded off edge. The siphonal part is very flatly rounded, and comparatively broad. In the specimen fig. 6 a breadth of the siphonal area of 7 mm. corresponds to a diameter of the shell of 58 mm. The umbilical margin is also distinctly marked, even in later stages of growth, but its character as an obtusely rounded edge is less conspicuous, because the adjoining umbilical wall slopes gently towards the umbilical suture. This moderate inclination of the umbilical wall gives a shallow character to the umbilicus.

The sculpture is similar to that of the preceding species, but no specimens have come to my knowledge in which the sculpture is so strongly developed as in some individuals of the thick variety of *O. serpentinum*. Folds and elongated, irregular bumps are either combined, as in the specimen fig. 6, or one of these two elements exclusively prevails (fig. 5). There are, moreover, forms in which the shell is almost perfectly smooth, but which on account of the distinct siphonal and umbilical margins, are more allied to the present species than to *O. chamunda*.

The shell is fairly well preserved in the specimen fig. 5, and is covered with very numerous, delicate lines of growth of an equal strength and distance. In such specimens, however, which are distinguished by the presence of narrow folds of sculpture, the growth lines are irregularly distributed into bundles corresponding to the

folds. An S-shaped striation of the cast corresponds to these growth lines of the shell. It is especially well marked in the siphonal region of the specimen fig. 6. The direction of the growth lines is not exactly the same as in the preceding species, at least near the umbilical wall, where they are not bent backward, but either straight or slightly turned towards the front of the shell. Near the siphonal margin they describe a strongly forward bent curve.

The spiral striation is exhibited as faint traces only on the siphonal area of the specimen fig. 6, and on a second one, which in its outlines approaches the normal spiral.

In one of the specimens from the Shalshal Cliff, which has not been figured, the lower extremity of the apertural margin near the umbilical suture is preserved. In this specimen the body chamber comprises very little more than one half a volution in length. In all the rest of the specimens less than one half a volution forms part of the body chamber.

Sutures.—In the type specimen, Pl. XII, fig. 5, the sutures are perfectly identical with those in the type specimen of *O. serpentinum* (Pl. XIII, fig. 2), but the range of variation in the shape of the lobes and saddles seems to be scarcely less wide in this than in the foregoing species.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 5, Coll. Diener; 1, Coll. Griesbach; Kiunglung encamping ground S. W. of Niti Pass 1, Coll. Griesbach.

Remarks.—The typical form is easily distinguishable from the allied species by its distinctly flattened siphonal area and the rounded off siphonal edges. But there is one specimen in which these characters are not very distinctly developed and which consequently somewhat recalls *O. serpentinum*, although the absence of any arching of the lateral parts places it nearer to the present species. The smooth specimens, in which barely any trace of sculpture is perceptible, mark transitional stages from this species to *O. Chamunda*. In one of the specimens the obliquely elliptical outline approaches the normal spiral. Thus in its outlines and in the strong elongated irregular bumps, this specimen recalls *O. gibbosum*, but the character of the siphonal region makes nevertheless distinction easy.

In general, the range of variation seems to be less wide in this than in the species hitherto described, because varieties with thick whorls and a deviating transverse section of the body chamber have not been observed.

GROUP OF OPHICERAS SAKUNTALA, DIENER.

5. (1) OPHICERAS SAKUNTALA, nov. sp., Pl. X, figs. 1-7, Pl. XI, figs. 1, 2, 4.

Dimensions.

	Pl. X. Fig. 1.	Pl. X. Fig. 2.	Pl. X. Fig. 4.	Pl. XI. Fig. 4.
Diameter of the shell	69mm.	44mm.	64mm.	49mm.
" " umbilicus	21	13	21	17
Height of the last volution { from the umbilical suture	30	20	25	20
Height of the last volution { " " preceding whorl	23	14·5	20·5	15
Thickness of the last volution	15·5	10	15	11

This species, which was partly confused by Griesbach with *Ophiceras demissum*, Oppel, partly with *Lecanites gangeticus*, de Koninck, is a frequent form in the main layer of the Otoceras beds in the Shalshal Cliff, where some of the limestone banks are almost exclusively made up of its shells. There are not less than 147 specimens of *O. Sakuntala* in the Himálayan collection, besides a large number of fragments, which I have not examined in detail.

The typical form of this species is very characteristic and is easily recognized; but the range of variation is so wide that there is no species of this group, with the exception of *O. Dharma*, to which transitional forms have not been observed. To *O. demissum*, *O. Chamunda* and *O. medium* the species is so intimately linked by transitional forms, that all these species might, perhaps, with equal justification, be considered as mere varieties of one and the same form; but in that case the range of variation in the species would be so abnormally wide, that distinctions between its different forms will necessarily have to be made. Whether these forms will have to receive a specific designation, or that of a variety only, is rather a matter of convenience. I prefer to promote the most typical among this large group of forms, which are all alike and all again different from each other, to the rank of proper species, and to circumscribe the range of their respective variations in the detailed description. A similar proceeding is generally adopted in the Brachiopoda, in which the typical, but not the extreme, forms are used for the separation of different species.

Typical form.—As such I consider the specimens figured Pl. X, figs. 1, 2, 3, 5, with volutions which increase more rapidly in height than in *O. demissum*, and overlap each other more than one half of their height. The umbilicus is usually smaller than the height of the last volution, whereas it is at least as large, but usually larger in *O. medium* and in *O. demissum*.

The transverse section is lanceolate and nearly twice as high as it is broad, and its greatest transverse diameter is situated a little above the umbilical margin, whereas in *O. medium* it exactly coincides with the latter. The lateral parts converge from this point towards the siphonal parts as very slightly arched planes. The siphonal part is narrowly rounded and passes very gradually into the lateral parts. The lateral parts slope very gently towards the umbilical margin from the point of the largest transverse diameter. The latter is always perfectly distinct, at least in the inner volutions, and takes the shape of a rounded off edge. From this edge the umbilical wall slopes to the umbilical suture at an angle of 45 to 60 degrees.

The ornamentation of the shell is very simple. The casts are either perfectly smooth, or are covered by numerous delicate falciform folds, which rise near the umbilical margin and increase gradually in breadth towards the siphonal margin, where they die out. These very low folds, which are neither narrow as in *O. tibeticum*, nor ever attain a similar strength, as in the typical forms of the former group, either begin on the inner volutions (Pl. X, fig. 5) or are confined to the last volution only. Occasionally slight, indistinctly defined elevations are also present on the inner volutions. In the shell these folds correspond exactly to the distribution of the lines of growth, which are always arranged along the folds in bundles and

developed more strongly than in the intervals. The direction of the lines of growth as well as of the folds is falciform in the lateral parts. On the umbilical wall their convexity is slightly bent backwards, whereas it is decidedly turned frontwards near the siphonal margin. In places where the cast is perfectly smooth, the growth lines of the shell are distributed quite regularly; but an arrangement into bundles, which are joined near the umbilical region, is the prevailing character.

Range of variation.—Several different directions of development are followed by this species. In one variation the tendency prevails to decrease the height of the volution, and to enlarge at the same time the size of the umbilicus. This tendency is clearly marked in the specimens figured Pl X, fig. 4, fig. 6, fig. 8 and Pl. XI, figs. 1 and 4. In the specimen Pl. X, fig 4, this tendency is combined with a considerably lessened amount of involution, the whorls overlapping each other to one third of their height only. In the specimen Pl. XI, fig. 2, the thickness of the cross section increases comparatively in proportion to the height, but not in size of the umbilicus. As in the same specimen a slight tendency is marked to enlarge the folds near the umbilical region, a beginning transition towards *O. gibbosum* may be observed.

Another character, which is subject to considerable variation, is the umbilical margin. Regarding the shape of the umbilical region, two evolutional series may be distinguished. In one the umbilical margin is an obtusely rounded off edge, as in this typical form, but the umbilical wall is higher and more steeply inclined. If the character is combined with the tendency to lessen the height of the volutions and to enlarge the umbilicus, transitional forms to *O. medium* are met with, as in the specimen figured Pl. XI, fig. 1. In the second evolutional series the umbilical wall gradually disappears by more completely rounding off the umbilical margin. Indeed there are specimens among the Himálayan material, which in the shape of the umbilical region approach the subgenus *Vishnuites* or *Xenaspis Middlemissi*, from the triassic limestone crags of Chitichun. In these specimens the lateral parts slope in a very regular curve towards the umbilical suture, without forming either a distinct umbilical margin or wall. The most intimate connection between all these forms, however, is indicated by a number of asymmetrical specimens, which show, only on one side, faint traces of a distinct umbilical margin, which is quite absent on the other.

Three specimens show a tendency to flattening of the siphonal part and the formation of indistinct, rounded off siphonal edges. But this tendency does not appear to be sufficiently strongly developed, to speak of true transitional forms between the present species and *O. platyspira*.

The concentric spiral striation is well marked in a considerable number of specimens, and is excellently developed in specimen Pl. X, fig. 4, where it is distributed all over the whorl. Under the lens these spiral striæ appear as low ridges of unequal strength and distance. They are situated nearest to each other in the vicinity of the siphonal part and on the umbilical wall, and are more delicate on the siphonal area, than on the lateral parts. Although in this specimen the shell is excellently preserved, and every detail of its numerous delicate lines of growth is visible under a magnifying glass, I have not been able to discover on it any trace of spiral

striations. I therefore cannot help thinking that the spiral striation in *Ophiceras* is restricted exclusively to the innermost layer of the shell, a character which has not yet been observed in any triassic ammonite, so far as I know.

In several of my specimens the margin of the aperture is at least partly preserved. Its general configuration is similar to that described in the preceding species. It forms a straight, radial line in the umbilical region, and a falciform curve in the lateral parts with a forward bent convexity in the siphonal area. The margin of the aperture is partly figured in the drawings Pl. X, figs. 3, 4, 6. In the two first mentioned specimens the body chamber comprises almost exactly one half of volution in length. In the specimen figured Pl. X, fig. 6, its size surpasses one half of the last volution by the twelfth part of its entire circumference.

Sutures.—An idea of the variation in the shape of the different elements of the sutural line may be formed by comparing the respective figures on Pls. X and XI. Two extreme types are represented by the figures 1c. and 2d. The saddles are either narrow and elongated or broad with flatly depressed tops. But the second lateral saddle is, as a rule, comparatively broad. The difference in the height of the lateral lobes and of the auxiliary lobe are very considerable in the specimens figured Pl. XI, figs. 1, 2, whilst they are insignificant in the specimen Pl. X, fig. 2. But one character of the sutural line is of specific importance, namely the denticulate termination of each of the lateral branches of the siphonal lobe. In Griesbach's type specimens of *Ophiceras medium*, each of these branches terminates in a single sharp point. This character has not been observed in any specimen of *Ophiceras Sakuntala*, as far as I know. In the specimen Pl. XI. fig. 1, which in general shape and involution resembles most *O. medium*, each of the lateral branches of the siphonal lobe shows a decidedly bicuspidate termination. In later stages of growth the number of indentations of the siphonal lobe increases.

The central incision in the apex of the siphonal prominence is always very distinctly marked, and in this respect the species does not differ from *O. tibeticum*. The siphonal funnel is comparatively broad, whilst the height of the siphonal prominence is also subject to a considerable variation, but it is always lower than the siphonal saddle.

The auxiliary lobe is either rounded off (Pl. X, fig. 2d), or forms a line of equal and regular indentations of varying length. In some specimens (Pl. X, figs. 1c, 8b) this straight umbilical series of indentations is of the same character as in many of the typical species of Waagen's genus *Prionolobus*.

In two of the specimens, remarkable variations of the development of the sutural line may be observed. In the specimen Pl. X, fig. 6, the two lateral branches of the siphonal lobe are asymmetrical, one terminating in a single point, the other being bicuspidate. In the specimen Pl. X, fig. 8, the second lateral saddle is bipartite, its top being indented by a small, secondary incision, which terminates in two sharp points, and this character is equally developed on both sides of the shell. A similar bipartite arrangement of the tops of the lateral saddles will be described in some species of *Otoceras*. If this character should be found to be a

constant one, and present in different specimens, it might be considered to be of specific value, and our specimen should be looked upon as the prototype of a proper species, but, for the moment, I prefer to consider its bipartite development of the second lateral saddle as abnormal only.

Siphuncle.—In the specimen Pl. XI, fig. 2, the siphuncle may be seen near the commencement of the last volution, in the shape of a narrow, fibrous string, which passes below the siphonal funnel.

Locality and Geological position. Number of specimens examined.—Otoceras beds, Shalshal Cliff near Rimkin Paiar encamping ground, 53, Coll. Griesbach; 87 Coll. Diener; Kiunglung encamping ground S.W. of Niti Pass, 6, Coll. Griesbach; S.E. of Muth, Spiti, 1, Coll. Griesbach; Lipu Lekh Pass, Eastern Johár, 1 (?), Coll. Griesbach.

Remarks.—Among the collection made by D. L. Iwanow in the lower triassic deposits of the Island Russkij in Eastern Siberia (Ussuri district) a few specimens were found, which are nearly perfectly identical with the typical form of *O. Sakuntala*. One of them agrees best with the Himálayan specimen Pl. X, fig. 2, another with the one figured Pl. X, fig. 4. They are indeed most probably identical with the species under consideration.

A species *Gyronites vermiformis*, Waagen (Ceratite formation, Pl. XXXIX, fig. 1), from the lower Ceratite sandstone in the Salt Range trias, is very similar to *O. Sakuntala*. Waagen himself characterizes his species as being very peculiar in its general appearance, and not adapted for a closer comparison with any of the other species of *Gyronites*, described in his Memoir. It cannot be compared with the typical form of *O. Sakuntala*, but to the variety with low whorls and a gradually curved umbilical margin. The sutural line is rather different in the two species; the siphonal lobe terminates in a single sharp point, with each of its branches, and is situated considerably deeper than the second lateral lobe. The siphonal prominence is very short and rounded above. The strange development of the auxiliary lobe may, perhaps, be explained by its being partly damaged by weathering.

The development of the sutural line seems to prove clearly that a specific identification of the two forms is not advisable. But even the relationship of *Gyronites vermiformis* to *Ophiceras* is doubtful, the concentric striations, which would form a decisive proof, being invisible, owing to the bad state of preservation of Waagen's type specimen.

6. (2) OPHICERAS MEDIUM, Griesbach, Pl. IX, figs. 1, 2.

1880. *Ophiceras medium*, Griesbach, Palæontological Notes on the Lower Trias of the Himálayas, Rec. Geol. Surv. Ind., XIII, 111, Pl. III, fig. 9.

Dimensions.

		Fig. 1.	Fig. 2.
Diameter of the shell		44 mm.	43 mm.
" " umbilicus		17 "	16 "
Height of the last volution	from the umbilical suture	16 "	16 "
	" " preceding whorl	9 "	12 "
Thickness of the last volution		10 "	10 "

The typical form of this species—as such Griesbach's type specimen (Pl. IX, fig. 1) is to be considered—is very similar to *Ophiceras tibeticum* in its general proportions, in its involution and in the shape of the transverse section, but its cast is perfectly smooth and devoid of lateral sculpture.

The cross section is lanceolate, and, as in *O. tibeticum*, the largest transverse diameter corresponds exactly to the umbilical margin. From this point the lateral parts converge in the shape of almost plane surfaces to the siphonal margin which, though rounded off, is distinctly defined, before passing into the moderately rounded siphonal part. The typical form of *O. Sakuntala* differs in this character; the siphonal part is highly rounded and passes in a very regular uninterrupted curve into the lateral parts.

The umbilical margin forms a distinct edge, from which the steeply inclined umbilical wall slopes towards the umbilical suture as a perfectly even plane, which is not arched at all.

The height of the transverse section is comparatively less than in the typical form of *O. Sakuntala*. It is less than the length of the diameter of the umbilicus, or just comes up to it.

Spiral striations have only been observed as faint traces in one of the specimens. Nor is the radial sculpture of the shell very distinctly developed. As has been remarked by Griesbach, it only shows slight radiating wrinkles, which disappear entirely towards the siphonal side and are only slightly bent forward in this region.

In Griesbach's type specimen the body chamber is completely preserved, comprising a little more than one half of a volution in length, but I have not succeeded in chiselling the margin of the aperture out from the surrounding matrix. All the specimens are of comparatively small size, smaller than the average size of *O. Sakuntala* and much smaller than *O. tibeticum*, and I believe that this species really did not attain so large dimensions as the two former. In all the specimens the body chamber is present.

Sutures.—It is only due to the scantiness of the material that the sutural elements exhibit a more constant character than in the preceding species. The saddles are broad and wide, especially the siphonal saddle, which is, however, lower than the principal lateral saddle. The siphonal lobe is situated at a comparatively low level. Its lateral branches terminate in one single sharp point. As this character may be observed even in the last septa of the type specimen, and persists at a diameter at which bi-/or even tri-cuspidate terminations are always found in *O. Sakuntala* or *O. tibeticum*, it appears to be of some value for a specific distinction of these forms.

The deep and bipartite antisiphonal lobe, with a rounded saddle on each side, was already noticed by Griesbach. It is perfectly identical with that in *O. tibeticum*.

Locality and Geological position. Number of specimens examined.—Otoceras beds, Shalshal Cliff near Rimkin Paiar encamping ground, 5, Coll. Griesbach; Kiunglung encamping ground S. W. of Niti Pass, 5, Coll. Griesbach.

Remarks.—Transitional forms exist between this species and *O. Sakuntala* and the smooth variety of *O. tibeticum*. The species under description is so inti-

mately connected with both these forms, that in some cases distinction becomes extremely difficult, although the typical forms are very easily recognized. The condition of the siphonal lobe seems to be a good characteristic for specific determination, although no important systematic value can be attributed to it on account of its great variability in all the congeneric species.

7. (3) OPHICERAS PTYCHODES, nov. sp., Pl. XI, figs. 3, 5, 6.

Dimensions.

	Fig. 5.	Fig. 6.
Diameter of the shell	56 mm.	61 mm.
" " umbilicus	18 "	23 "
Height of the last volution { from the umbilical suture	20 "	23 "
Height of the last volution { " " preceding whorl	16 "	17 "
Thickness of the last volution	11·5 "	13 "

This elegant species is very closely allied to *O. Sakuntala*, but differs owing to its stronger, falciform ribs, which cross the siphonal part. In general shape it does not agree with the typical form of *O. Sakuntala*, but rather with its variety with lower whorls and shallow umbilical region, devoid of distinct umbilical margin. In the specimens, figs. 3 and 5, the transverse section is lanceolate, but in the specimen fig. 6 it is somewhat oval, the lateral parts converging but very little towards the broadly rounded siphonal area. Neither siphonal nor umbilical margins are distinctly represented. The lateral parts join the penultimate whorl in a flat and regular curve. Only the inner volutions show an umbilical wall, which is distinct from the sides.

In the specimens, figs. 3 and 5, the diameter of the umbilicus is decidedly smaller than the height of the last volution, whilst the opposite character prevails in specimen, fig. 6. The involution is about the same as in the typical form of *O. Sakuntala*, the whorls overlapping each other to a little less than one half of their entire height.

The sculpture is very elegant and characteristic, consisting of falciform folds arranged in the same manner as in *O. Sakuntala*, but more strongly developed. They gradually increase in size near the upper portion of the lateral parts and in the typical forms of this species (Pl. XI, figs. 3, 5) cross the siphonal area. Thus even along the periphery of the shell, this sculpture may be seen as a regular corrugation; in specimen, fig. 6, the folds are not yet sufficiently strongly developed to cross the siphonal part. The latter specimen may therefore be looked upon as a transitional form to *O. Sakuntala*.

The growth lines of the shell correspond exactly to the folds in the cast. As in *O. Sakuntala*, they are arranged in bundles, which are combined near the umbilical margin.

In specimen, fig. 3, the spiral striations of the cast are excellently developed and regularly distributed all over the cast. They are very delicate and seem to be more numerous near the umbilical region and the siphonal margin, than on the middle portion of the lateral parts.

In specimens figs. 3 and 6 the margin of the aperture is partly indicated. In its immediate vicinity the transverse diameter of the shell is slightly larger. In both specimens the body chamber comprises but very little more than one half a volution in length.

Sutures.—The sutural line agrees with that of *O. Sakuntala.* In specimen fig. 6 the arrangement of the terminal denticulations in each of the lateral branches of the siphonal lobe is rather remarkable. Each branch ends in two sharp points, which are flanked by two smaller indentations higher up. The central incision at the top of the siphonal prominence is very distinctly developed. The two lateral saddles are skew-shaped in the direction of the internal (umbilical) side.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 3, Coll. Diener.

Remarks.—Many palæontologists will probably consider this species as a variety only of *O. Sakuntala*, and there is indeed little to urge against such a view, but I have preferred to give a specific designation to this form on account of its conspicuous sculpture.

8. (4) Ophiceras demissum, Oppel, Pl. XIV, fig. 1—7.

1865. *Ammonites demissus*, Oppel, Ueber ostindische Fossilreste aus den secundären Ablagerungen von Spiti und Gnari Khorsum in Tibet, Palæontologische Mittheilungen aus dem Museum der königl-bayer. Staates, Stuttgart, I. Pl. LXXXVI, fig. 1. p. 290.

1880. *Xenodiscus demissus*, Griesbach, *pro parte*, Palæontological Notes on the Lower Trias of the Himálayas Rec. Geol Surv. Ind., XIII. p. 112.

Dimensions.

	Fig. 2.	Fig. 3.	Fig. 5.
Diameter of the shell	48 mm.	34 mm.	18 mm.
„ „ umbilicus	19 „	15 „	9·5 „
Height of the last volution { from the umbilical suture	17 „	11 „	5 „
„ „ preceding whorl	13 „	9 „	3 „
Thickness of the last volution	11 „	7 „	4 „

The identification of this with Oppel's species has given me some trouble because Oppel's type specimen, although provided with body chamber, does not represent a full grown individual. But a detailed examination of the material contained in the Schlagintweit collection in Munich, for permiting, which I am greatly indebted to Geheimrath K. A. von Zittel, has convinced me that this determination is justified. The matrix, in which Oppel's specimens are imbedded, is lithologically of the same character as the lower banks of the Otoceras beds at Kiunglung E. G. Although the locality, from which they are derived, Tengdi in Western Spiti, is not known to me personally, there can be no doubt that Oppel's *O. demissum* has been collected in true Otoceras beds, no mesozoic rock series in the Himálayas being so characteristic as this one and it may easily be recognized from hand specimens only. Moreover some of Oppel's specimens agree absolutely in dimensions, general shape and sculpture with several of the smaller specimens from Kiunglung and the Shalshal Cliff. It only needs a comparison of the respective measurements in Oppel's type specimen and in the one from the Shalshal Cliff

figured Pl. XIV, fig. 6, to illustrate their identity as far as their dimensions are concerned.

	Oppel's type. Specimen.	Pl. XIV. Fig. 6.
Diameter of the shell	21 mm.	20 mm.
" " umbilicus	9·5 "	9 "
Height of the last volution	6 "	6 "
Thickness of the last volution	4 "	4 "

The striking similarity in the sculpture is best exhibited by a comparison of the last-mentioned specimen with the one figured Pl. XIV, fig. 7, from the Schlagintweit collection. The narrow low folds and wrinkles, characterizing this species in the adolescent stage may easily be observed in both figures.

I believe, therefore, that the specific designation proposed by Oppel may safely be adopted for this species. As the specimens belong certainly to *Ophiceras*, Oppel's *Ammonites demissus* will consequently have to be placed in this genus.

Typical form.—The typical form of this species is, of course, represented by Oppel's specimen, and by specimens figs. 2, 3, 5, 6, 7, which in shape and sculpture exhibit the greatest similarity to the former. The typical form may be distinguished from *O. Sakuntala*, which is its nearest ally, by the wider umbilicus, by its more numerous, slowly increasing volutions, and by its transverse section, which is more oval than lanceolate.

The diameter of the umbilicus is considerably larger than the height of the last volution. The involution is very small in younger stages of growth, as may be seen from the specimens figs. 3, 5, 6, 7, but increases considerably after the diameter has attained more than 20 mm. But even then it is smaller than in the typical form of *O. Sakuntala*. The height of the transverse section is lower in proportion to its thickness, than in the former species. The largest transverse diameter is situated a little above the umbilical margin, which, as a rule, is distinctly defined, at least in the inner volutions. The umbilical margin forms an obtusely rounded edge, and is separated from the preceding whorl by a distinct, steeply inclined umbilical wall of varying height. As it is rather low in the inner volutions, it contributes to the shallow aspect of the wide umbilicus.

The lateral parts converge very slightly towards, and gradually pass into, the broadly rounded siphonal area.

The specimen fig. 1 differs from this typical form by comparatively higher whorls in and by a larger degree of involution, the whorls overlapping each other rather less than one half of their height. The umbilical margin is more rounded off and there is no distinct demarcation between the moderately inclined umbilical wall and the flat lateral parts. Specimen fig. 4 agrees with the typical form in involution, but differs owing to the absence of a distinct umbilical margin.

The sculpture is subject to some variation. As a rule the inner volutions are perfectly smooth. At a diameter of 6 to 20 mm. however, a very characteristic sculpture prevails; it consists of very numerous, delicate and narrow falciform wrinkles, between which a few stronger ones are intercalated. This irregularity in

strength of the wrinkles is very conspicuous in most of the specimens. In the adolescent stage they are frequently replaced by low folds, as, for instance, in the specimen fig. 3, but in others the sharp narrow irregular wrinkles persist even in full-grown individuals, as, for instance, in the specimen fig. 4. In the body chamber as a rule, the sculpture is similar to that noticed in *O. Sakuntala*. The same remark applies to the growth lines in the shell.

The concentric striation is well developed on the casts of the specimens figs. 1 and 3, especially of the latter. The distribution of the spiral striæ is similar to that described in *O. Sakuntala*.

In Oppel's type specimen the body chamber amounts to rather more than one half a volution in length. So it does in the specimen Pl. XIV, fig. 2, in which it exceeds one half of the last volution by the twelfth part of the length of the entire circumference. In this specimen the margin of the aperture is entirely preserved. It is slightly falciform, directed backward in the umbilical region, and slightly turned forward in the siphonal part. In the specimen fig. 1 the commencement of the margin of the aperture is indicated near the umbilical region, of the last whorl. In this specimen the length of the body chamber scarcely exceeds one half of a volution.

Suture.—In general identical with those of *O. Sakuntala*. The sutural line figured Pl. XIV, fig. 1b, is remarkable owing to its sloping umbilical lobe, which forms a straight row of denticulations, as described by Waagen of the genus *Prionolobus*. The shape of the auxiliary lobe varies, however, in this as well as in other congeneric species, its denticulations being either arranged in a straight line, or in a regularly rounded arch. The lateral branches of the siphonal lobe are denticulated below.

Locality and Geological position. Number of specimens examined.—Otoceras beds, Tengdi (Spiti) 5, Coll. Schlagintweit (from the State Palæontological Museum in Munich); Shalshal Cliff near Rimkin Paiar encamping ground, 6, Coll. Diener 6, Coll. Griesbach; Kiunglung encamping ground S.W. of Niti Pass, 9, Coll. Griesbach, 2, Coll. Diener.

Remarks.—Between this species and *O. Sakuntala* there are transitional forms, but the types of both species may easily be distinguished by the difference in involution, cross-section and sculpture of the inner portion of the whorls.

9. (5) Ophiceras Chamunda nov. sp., Pl. XII, figs. 1, 2, 3, 4.

Dimensions.

	Fig. 1	Fig. 2
Diameter of the shell	63 mm.	49 mm.
" " umbilicus	23 "	16 "
" " shell } at the place of its greatest splanation	47 "	37 "
" " umbilicus } at the place of its greatest splanation	16·5 "	11 "
Height of the last volution { from the umbilical suture . .	24 "	20 "
Height of the last volution { " " preceding whorl . .	19 "	17 "
Thickness of the last volution	14 "	13 "
Height } of the last whorl at the place of its greatest splanation.	18 "	15 "
Thickness } of the last whorl at the place of its greatest splanation.	13·5 "	11 "

The relation between this species and *O. Sakuntala* are similar to those which exist between *O. serpentinum* and *O. tibeticum*. *O. Chamunda* may be roughly defined as the elliptical variety of *O. Sakuntala*, with the difference, however, that its range of variation is much smaller than that of the latter species.

In my Memoir on the Cephalopoda of the Muschelkalk I have already given my opinion, which is in accordance with that of E. v. Mojsisovics, that the obliquely elliptical shape of *Japonites Sugriva* (Pl. VII, fig. 1) and of some species of *Gymnites* must be considered as an original character, proper to these species, and cannot be due to a later and accidental deformation of the fossils in the matrix. This question seems to me to be settled by the discovery of a very large number of forms, belonging to the genus *Ophiceras*, which are distinguished by an elliptical shape, not only occurring together with others characterized by normal outlines, but with every detail of their structure so marvellously preserved (for instance in the specimen Pl. XII, fig. 2) that the idea of any later accidental deformation must be given up. Thus we must return to Stoliczka's view, who in describing his *Gymnites Batteni*, expressly remarked that its elliptical outline ought to be considered as a proper character of the species.[1] Whether a specific rank ought to be attributed to these elliptical forms, or that of a mere variety only, is a matter of personal taste.

With the exception of the elliptical outlines, our species agrees so well in every other respect with *O. Sakuntala* that a detailed description of all its characters is scarcely necessary, as I should only have to repeat the description of the latter species. It must be noticed, however, that only in very few specimens are traces of a distinct umbilical margin observable, and that in the typical form of *O. Chamunda*, the lateral parts pass quite regularly and with a gradually increasing curve into the low umbilical wall. In some specimens no umbilical wall is at all present, the lateral parts of the last volution joining the penultimate whorl under a moderately flat angle.

In none of my specimens the margin of the aperture is preserved, but its vicinity is indicated in the specimen fig. 2 by a slight enlargement of the last volution near its anterior termination.

The sculpture of the shell and the details of the sutural line are absolutely identical with those of *O. Sakuntala*.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 30, Coll. Diener; Kiunglung encamping ground, N. W. of Niti Pass, 2, Coll. Griesbach; 1, Coll. Diener; Hills above Kuling, Spiti, 2, Coll. Griesbach; Khar, Spiti, 2, Coll. Griesbach.

Remarks.—This species exhibits a remarkable similarity to a Siberian form from the Olenek beds, which E. v. Mojsisovics described as *Xenodiscus karpinskii* (Arktische Triasfaunen, Pl. XI, fig. 13, p. 75). A specific identity, it is true,

[1] Mem. Geol. Surv. Ind. V, pt. I, p. 60.

is beyond all probability, seeing the difference in shape of the transverse section; but whether a generic relationship exists between both forms, cannot be decided. The elliptical outlines of the Siberian species speak in favour of such a view. Mojsisovics has likewise interpreted it as an argument in favour of a close connection of his *Xenodiscus Karpinskii* with *Gymnites*.

10. (6) Ophiceras Dharma nov. sp., Pl. XV, figs. 8, 9.

Dimensions.

Diameter of the shell	41 mm.
" " umbilicus	16 "
Height of the last volution { from the umbilical suture	13·5 "
Height of the last volution { " " preceding whorl	11 "
Thickness of the last volution	8 "

This is the only species of *Ophiceras* with biangular outlines, its siphonal area being perfectly flat and bordered by sharp marginal edges.

Numerous, very slowly increasing whorls, encircle a wide and very shallow umbilicus, and their involution is comparatively small. The whorls apparently do not overlap each other more than one quarter of their entire height. The transverse section is perfectly oval, excepting the flattened siphonal area. The largest transverse diameter coincides with the middle portion of the lateral parts. The latter are very regularly arched. In one of the specimens an umbilical margin is indistinctly indicated; in the other it is altogether absent. But, regarding the variability of the character in *Ophiceras*, I can see no reason in this slight difference to separate these two specimens specifically.

The siphonal part is quite flat and bordered by distinct, sharp marginal edges as far as the anterior termination of my specimens. Its breadth has been considerably exaggerated in the drawing fig. 8b, as it is in reality not more than 2 mm broad.

The ornamentation of the shell is but faintly marked. In the penultimate whorl it consists of very low, delicate, radiating folds; in the last volution of numerous thin thread-like and falciform striations, which correspond to the growth-lines in the shell. In the fragment fig. 9a a very low spiral ridge may be observed, situated a little above the centre line of the lateral parts. It is chiefly on account of this sculptural element, which recalls the similar spiral ridges in full grown specimens of *Gymnites* (*G. Ugra*, *G. jollyanus*), that I have ventured to place the species among the genus *Ophiceras*.

Sutures.—I have not been able to discover a trace of the sutural line in the more complete specimen. The fragment fig. 8 comprises the body chamber portion of the last volution.

Locality and Geological position. Number of specimens examined.—Otoceras beds. South of Dharma No. XI, Lissar Valley, Johár, 1, Coll. Griesbach; Shalshal Cliff near Rimkin Paiar encamping ground, shales above the main-layer of *Otoceras Woodwardi* 1, Coll. Diener.

Sub-family: *MEEKOCERATINÆ* (Mihi).

Genus: MEEKOCERAS, Hyatt.

The genus *Meekoceras* was first proposed by A. Hyatt in 1879[1] but the figures of the triassic forms from Idaho, which had induced Hyatt to propose this new generic designation, were only published in 1880.[2] With the exception of the Indian and European species, which had been erroneously placed into this new genus by its author (*Balatonites ottonis, Dorycranites boydianus, Xenaspis carbonaria*), *Meekoceras* comprises four species in the American lower trias. These are the following:

(1) *Meekoceras aplanatum*, White (Pl. 31, figs. 1 *a, b, d*) and a second one allied to the former but differing by its numerous volutions, which barely touch each other; for this second species (Pl. 31, fig. 1*c*) the name *Gyronites whiteanus* was lately introduced by Waagen.

(2) *Meekoceras mushbachianum*, White (Pl. 32, figs. 1 *a, b, c, d*).

(3) *Meekoceras gracilitatis*, White (Pl. 32, fig. 2 *a, b, c, d*).

In 1882 E. v. Mojsisovics[3] removed the two first-mentioned species from the genus *Meekoceras* and united them with Waagen's genus *Xenodiscus*, which had been likewise introduced in 1879. Thus only the forms distinguished by high whorls and by a narrow umbilicus remained in the genus *Meekoceras*. E. v. Mojsisovics was induced to do so in the belief that *Xenodiscus carbonarius*, Waagen represented the prototype of the genus *Xenodiscus*. This view he maintained in his Memoir on the Cephalopoda of the Arctic regions, when he removed *Xenodiscus plicatus*, Waag. from this genus and placed it among his group of the *Ceratites obsoleti*.

As has been fully explained in the introduction to *Xenaspis*, the generic independence of *Xenodiscus plicatus* from the *Ceratites obsoleti* (sub-genus *Danubites*) is advocated by Waagen in his great Memoir on the triassic cephalopoda of the Salt Range. As *Xenodiscus plicatus* is the first species, which was described under that generic name, the latter must remain with it. The question consequently arises, which among the four species, to which the name *Meekoceras* has been originally applied, ought to be considered to be the typical one? Waagen decided the question in favour to *M. gracilitatis* (Ceratite formation p. 217) and he consequently introduces a new designation for the species with large umbilici and low volutions, which constitute his genus *Gyronites*.

Although this question seems to be only a formal one, I must enter into its details, because it is apt to lead to grave confusion in the nomenclature of the triassic cephalopoda.

[1] C. A. *White*. fossils of the Jura-Trias of South-Eastern Idaho, Bull. U. S. Geological and Geographical Survey of the territories, V, 111.

[2] C. A. *White*. Contributions to invertebrate palæontology, No. 5, Triassic Fossils from South-Eastern Idaho XII. Annual Report of the U. S. Geological Survey for the year 1878, Pt. ii, p. 112.

[3] E. v. *Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlgn k. k. geol. Reichs-Anstalt X, 1882, p. 213.

I may state at once that I agree perfectly with Waagen about the impossibility of deducing an exact diagnosis from Hyatt's definition of his genus, and I am further obliged to add that all the characters enumerated in Hyatt's diagnosis apply equally well to each of his four American species.

Now Waagen explains his view of this matter in the following words (p. 217): "Generally one considers as type of a genus that species, which has been described as the first under that generic name, and thus *Meekoceras aplanatum* ought to be considered as the typical species in this case. I think, however, that an exception from the rule should be established here, inasmuch as the first species, mentioned by Hyatt in the description of the genus, should be taken to represent the type of the genus, as it appears from the text, that most probably Hyatt himself has considered the most involute form as the typical one, and in this case *Meekoceras gracilitatis* would be this form. This agrees at the same time with the general view which has been established by E. v. Mojsisovics in the matter, as he also is of opinion that forms with narrow umbilici and compressed whorls ought to be considered as constituting the genus *Meekoceras*."

The text of Hyatt's diagnosis, which is quoted by Waagen, runs as follows:

"These species, so far as they go, are unlike the *Ceratites* of any foreign locality, but have more resemblance to the Muschelkalk than to the St. Cassian or Hallstatt faunas. They possess in common one characteristic, which separates every species from the typical forms of European *Ceratites*. There are but three distinct lateral cells and two lateral lobes, besides the finer auxiliary lobes and cells. This occurs in the most involute species, 'G.' [*Meekoceras gracilitatis*] as well as in the least involute [*Meekoceras aplanatum*]."

It is scarcely evident from this passage, that Hyatt himself considered *M. gracilitatis* as the typical species of his genus. I believe, on the contrary, that he treated the involute and evolute forms as of perfectly equal rank, because he expressly remarks that the character, which induced him to propose his new genus, is common to both of them. I consequently think that the question, which species has to be considered as the prototype of the genus, can only be decided by priority.

It must be conceded that from White's Memoir, in which the name *Meekoceras* is used for the first time, a satisfactory decision is not at all easy. The first species, described as *Meekoceras*, is *M. aplanatum*, but the first species, mentioned in the text of the diagnosis, is *M. gracilitatis*. Although I think that, in general, the rules of priority are in favour of the first species, described under a generic designation, a different view of the subject cannot be absolutely refuted.

A way which might lead out of this difficulty has been indicated by Waagen, namely, to follow the interpretation of the first author, who accepted Hyatt's genus *Meekoceras*. This is E. v. Mojsisovics, and Waagen lays special stress on the fact that he is in accordance with this author's opinion "that forms with narrow umbilici and compressed whorls ought to be considered as constituting the genus *Meekoceras*."

But in this respect I am at variance with Waagen's view. In his Memoir on

the Cephalopoda of the Mediterranean triassic province, E. v. Mojsisovics has expressed his opinion quite distinctly on the subject, in the following note to his remarks on the genus *Meekoceras* (p. 213) :—

"As a distinct type has not been established for the genus *Meekoceras*, the first form described as *Meekoceras* ought to be decisive in this respect. But this form, *Meekoceras aplanatum*, White, belongs to the genus *Xenodiscus*, which was proposed by Waagen about the same time (1879). The figures of the American forms, which induced Hyatt to propose *Meekoceras*, were published in July 1880 only, whereas Waagen at once gave an exact diagnosis of his genus *Xenodiscus*, illustrated by figures. Thus *Meekoceras*, adhering rigorously to the rules of palæontological terminology, falls among the synonyma of *Xenodiscus*."

From this passage it is evident that E. v. Mojsisovics was of opinion that *M. aplanatum* was the proper type of the genus, and that he only restricted the name *Meekoceras* to the forms with narrow umbilici, because he considered the former species as identical with *Xenodiscus*. Since it has been proved by Waagen himself that this is not the case, and that *Meekoceras aplanatum* is very different from the true *Xenodiscus*, this species quite naturally becomes again the type of the genus *Meekoceras*. At this conclusion we must necessarily arrive if we strictly adhere to the view of E. v. Mojsisovics in this matter. But as this author was the first to accept Hyatt's new genus, I think that his interpretation really ought to be taken as the authentic one.

Meekoceras aplanatum differs from *M. gracilitatis* and *M. mushbachianum* by its wide umbilicus, its comparatively low volutions, and by the absence of an auxiliary lobe. If the absence of an auxiliary lobe and a difference in the height of volutions should be found to be characters of generic importance, the name *Meekoceras* must be confined almost exclusively to *M. aplanatum*, and in this case consequently *Meekoceras* would not exist either in the European, Himálayan or Siberian trias.

The confusion, in triassic palæontological nomenclature, which would necessarily result from this restriction of the name *Meekoceras*, can, I believe, be easily avoided. The characters by which *Meekoceras aplanatum* differs from *M. mushbachianum* and from *M. gracilitatis*, are not, I think, of sufficient importance to involve the necessity of a generic separation.

The development of an auxiliary lobe is a character of so small systematic value, that it is evident from the development of *Dinarites* and *Tirolites* that it does not afford a satisfactory reason for introducing a new genus. If this character ought to be considered of generic importance in *Dinarites*, or in *Tirolites* for instance, one single species, *Dinarites spiniplicatus*, v. Mojsisovics, would have to be split up into not less than four genera. But this proceeding would scarcely meet with the assent of any palæontologist. Waagen himself, who in the description of his family of the *Meekoceratidæ* gave unusually narrow limits to the genera, considered the absence of an auxiliary lobe as a character of not even sub-generic value. He, for instance, leaves *Gyronites nangaensis* (Ceratite forma-

tion l. c. Pl. XXXVII, fig. 5) in his genus *Gyronites* distinguished as a rule by the presence of distinct auxiliary lobes, although in this species an auxiliary lobe is not only entirely wanting, but even the second lateral saddle, as in *Meek. aplanatum*, is not situated entirely outside the umbilical suture.

Nor can I admit a generic distinction justified by a difference in the height of the transverse section and in the mode of involution only. E. v. Mojsisovics (Arktische Triasfaunen p. 75) remarks, expressly, that he would not have made a generic distinction between *Xenodiscus* and *Meekoceras* by reason of a difference in the height of their volutions, but because he supposed the two genera to be the ancestors of two different genetic series. This reason does, however, not apply to *M. aplanatum* and the rest of its American congeneric species.

A generic distinction on the strength of such characters would be the more difficult, as in this respect no sharp boundary can be drawn between *M. aplanatum* and *M. mushbachianum*; if, for instance, in accordance with E. v. Mojsisovics *Meekoceras euomphalum* (Arktische Triasfaunen Pl. XI, fig. 7, p. 76) is looked upon as *Xenodiscus* on account of the height of its volutions, *M. mushbachianum* with still lower whorls and a larger umbilicus must also be placed into the group of forms allied to *M. aplanatum*. But Waagen rightly considers *M. mushbachianum* to be a nearer ally to *M. gracilitatis* owing to the arrangement of its sutural line. One must therefore make a generic distinction between *Ptychites Malletianus*, Stoliczka, with its large umbilicus (Mem. Geol. Surv. of India, V, Pl. V, fig. 1, p. 58), and the rest of *Ptychites*, between the geologically older and younger forms of *Gymnites*, distinguished by a different size of their umbilicus; in a word, one would have to introduce complete confusion into the palæontological nomenclature of triassic ammonites.

I believe it therefore to be more judicious to leave all the forms described by C. A. White in the genus *Meekoceras*, and to make no generic distinction between those closely allied species.[1] It is true that in this case a considerably larger range is given to the genus, and that it will thus contain a very large number of forms. But this difficulty can be easily avoided by uniting groups of forms allied by remarkable proper characters into sub-genera. Dr. Waagen has in this manner made a most ingenious use of the development of the auxiliary series for a distinction of the majority of his generic members, composing his family *Meekoceratidæ*. Most of these genera might, according to my view, be looked upon as sub-genera of *Meekoceras*. As sub-genera of *Meekoceras* I should prefer to consider, *Koninckites*, *Kingites*, *Aspidites* and *Beyrichites*. It must not be forgotten that a generic distinction, founded on the development of the auxiliary series only, is not in accordance with the general custom of the interpretation of the extent of single genera. It appears to me that Waagen's genera in the family of the *Meekoceratidæ* are too narrowly circumscribed, compared with any other family of Cephalopoda, and I venture to suggest that their real relative systematic value is only that of sub-genera.

[1] With the exception perhaps of *Meekoceras whiteanum*, Waagen, which might turn out to be an *Ophiceras*.

Thus *Meekoceras sensu stricto* ought to be retained for those forms which have been attributed to *Meekoceras* and to *Gyronites* by Waagen. Waagen's diagnosis of *Meekoceras* may be left almost unchanged. *Meekoceras sensu stricto* will comprise forms with either large or narrow umbilici, in which the development of the auxiliary series, if any is present at all, has only reached the formation of one single, distinc auxiliary lobe. In the sub-genus *Koninckites*, Waagen, the development of the auxiliary series has advanced to the individualization of the first auxiliary saddle, and, in some forms, even to that of a second auxiliary lobe. In *Kingites* the auxiliary series consists of a varying number of denticulations, which are of unequal size and stand all on the same level. In *Aspidites* distinct auxiliary members are to be distinguished among this long row of coarse and irregular denticulations. I have stated already in the discussion of the genus *Proptychites* that I consider *Beyrichites*, Waagen, also, as a member of the *Meekoceratidæ* on account of its mode of development differing entirely from that noticed in the *Ptychitidæ*, and so I need not enter here again into this question.

Among the Himálayan representatives of the genus *Meekoceras* of lower triassic age, five belong to *Meekoceras sensu stricto*, two to *Koninckites*, one to *Kingites*, one to *Aspidites*.

Thus we arrive at the following arrangement of the species of *Meekoceras*, which occur in the lower trias of the Himálayas.—

I. MEEKOCERAS *sensu stricto*.

1.—*Meekoceras boreale*, Diener, Otoceras beds.
2. „ *Hodgsoni*, nov. sp., Otoceras beds.
3. „ *cf. fulgurato*, Waagen, subrobustus beds.
4. „ *sp. ind. ex. aff. plicatili*, Waag., Otoceras beds.
5. „ sp. ind., Otoceras beds.

II. KONINCKITES, Waagen.

1. (6) *Koninckites Vidarbha*, nov. sp., Otoceras beds.
2. (7) „ *Yudishthira*, nov. sp., subrobustus beds.

III.—KINGITES, Waagen.

1. (8) *Kingites Varaha*, Dien., Otoceras beds.

IV.—ASPIDITES, Waagen.

1. (9) *Aspidites superbus*, Waagen, var., subrobustus beds.

1. MEEKOCERAS BOREALE Diener, Pl. VII, fig. 1, Pl. XXIII, fig. 8.

1895. *Meekoceras boreale* Diener, Mittheilungen ueber triadische Cephalopodenfaunen von der Ussuri-Bucht under Insel Russkij in der Ostsibirischen Küstenprovinz, Sitzgsber. kais. Akad d. Wiss Wien, math. nat. Cl., CIV. pt. 1. 1895, p. 272.

Dimensions.

Diameter of the shell	41	mm.
„ „ umbilicus	4·5	„
Height of the last volution, from the umbilical suture	22	„
Height of the last volution, „ „ preceding whorl	15	„
Thickness of the last volution	11	„

This species, of which two incomplete specimens exist, is characterized by the biangular shape of its siphonal region, by slowly increasing, but very involute whorls, which overlap each other to a very considerable extent, and by a narrow umbilicus.

The transverse section is twice as high as broad. The largest transverse diameter corresponds almost with the middle of the height of the lateral parts. The latter are quite regularly arched and slope from the centre line in a flat and even curve towards the umbilical and siphonal margins. A sharp marginal edge, which persists even in the body chamber portion of the shell, separates the lateral parts from the flat but comparatively narrow siphonal area. At the anterior termination of the fragment, Pl. VII, fig. 1, the breadth of the siphonal part is 3 mm. Towards the umbilical suture the lateral parts slope quite regularly, no umbilical wall nor edge being indicated.

None of the shell is preserved in any of the specimens. The cast is without any distinct sculpture, only in the specimen Pl. VII, fig. 1, a few delicate radial striations may be noticed in the vicinity of the siphonal part, and faint traces of S-shaped ribs may be observed on the lateral parts. In this fragment the smaller portion of the last volution forms part of the body chamber. The second specimen is entirely chambered.

Sutures.—The sutural line is entirely preserved, and is especially distinguished by a broad, denticulated siphonal lobe and by an auxiliary series which consists of a single serrated auxiliary lobe and a broad, flatly arched auxiliary saddle. The deep and unusually broad siphonal lobe is divided by a pyramid shaped siphonal prominence, which reaches up half as high as the siphonal saddle and is provided with a broad siphonal funnel. The denticulations at the bottom of each of the lateral branches in the siphonal lobe are not of quite equal size, but slightly irregular. The principal lateral lobe stands deeper than the rest. The principal lateral saddle is comparatively large, surpassing considerably the siphonal saddle. The second lateral saddle is very broad and flatly arched, imitating in this respect the outlines of the auxiliary saddle. The first auxiliary lobe is distinctly individualized and serrated. The auxiliary saddle stands entirely outside the umbilical suture, but no auxiliary lobe is yet noticed adjoining it. I consequently prefer to place this species among *Meekoceras sensu stricto*, although it may be looked upon as a transitional form to *Koninckites* on account of the probable individualization of the auxiliary saddle.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 1, Coll. Diener; South of Dharma, No. XI, Lissar Valley, Johár 1, Coll. Griesbach.

Remarks.—This species is identical with one among the collections of D. L. Iwanow in the triassic sandstones of the Island Russkij in the Siberian Littoral Province. One specimen, which will be figured in the Mémoires du comité géologique de la Russie, Vol. XIV, No. 3, Pl. I. fig. 3, agrees absolutely with this Himálayan specimen.

To this species a second form from the same Siberian locality is so closely allied, that it will perhaps have to be considered as a variety only, if better preserved materials should be forthcoming. It will be figured in the above-mentioned Memoir on Pl. I, figs. 4 and 5; seems to differ only by a somewhat lesser involution and by a slightly wider umbilicus.

It is rather difficult to compare ***Meekoceras boreale*** with other congeneric forms, not so much on account of the real absence of closely allied species, but on account of the insufficiency of their respective descriptions and figures.

This remark especially applies to the American representatives of the genus ***Meekoceras***, among which ***M. gracilitatis*** White,[1] from the Meekoceras beds of Idaho is perhaps more closely allied to our species than it appears on first sight. In their outlines the two species are very similar, although ***M. gracilitatis*** is provided with a rather wider umbilicus, with a distinct umbilical margin and with a sloping umbilical wall. The character of the sutural line is identical in the two species as far as the commencement of the auxiliary series. Outside the second lateral saddle of ***M. gracilitatis*** a flat auxiliary lobe seems to follow provided with a few denticuations, but far less distinctly individualized than in ***M. boreale***. This lobe is followed by a small auxiliary saddle. From White's own description it is, however, evident that several different forms have been united by him under this specific name. For instance, the two figures Pl. XXXI, figs. 2a and 2b, probably belong to two different species, the form fig. 2b being apparently distinguished from the typical ***M. gracilitatis*** (fig. 2a) by more rapidly increasing whorls and by a different sculpture. The sutural line (fig. 2d), however, is taken from neither of these two specimens. The arrangement of the sutures in the typical ***Meekoceras gracilitatis*** consequently remains uncertain. This uncertainty is still increased by the following contradictory remarks in White's text. In his description of ***M. gracilitatis*** (p. 115) the author states that "the inner cell," *i.e.*, the second lateral saddle, "is not defined upon its inner side for want of another full lobe there," whereas in his description of ***M. gracilitatis*** var. (p. 116.) he remarks, that in this variety "the inner lateral cell is smaller than in the typical forms, and its inner border is not as abruptly defined from the auxiliary series." Thus it remains uncertain whether in the typical ***M. gracilitatis*** the inner side of the second lateral saddle is, or is not, distinctly defined from the auxiliary series. Regarding the sculpture of ***M. gracilitatis***, White remarks "that in the fully adult shells there is a tendency to form nodes or ribs, the latter sometimes crossing the periphery."

From these instances it is evident that a revision of the fauna of the American ***Meekoceras*** beds is unavoidable, before any closer comparison with foreign congeneric species can be attempted. For the present, a comparison of the Indian and Siberian, with the American forms of ***Meekoceras***, is almost impossible, on account of the insufficiency of the descriptions and figures.

[1] *C. A. White*, Triassic fossils of South-Eastern Idaho, XII. Annual Report U. S. Geol. Survey of the territories for the year 1878, Pt. II. p. 115, Pl. II, fig. 2.

Similar difficulties are met with, if we try to compare our species with *Meekoceras planulatum*, de Kon.,[1] from the triassic beds of the Salt Range.

A specimen with a diameter of 48 mm. which is united by Waagen (Ceratite-formation l. c. Pl. XXIV, fig. 2) with *M. lanulatum* exhibits a remarkable similarity with the present species in its general outlines, although it possesses a wider umbilicus, and a rather steeply inclined umbilical wall. Unfortunately Waagen's specimen does not show any trace of the sutural line, which thus is only known to us through L. de Koninck's drawing, the type specimen having been lost. Like *Meekoceras boreale, M. planulatum* is also provided with a broad siphonal lobe "with a deep angular siphonal tubercle in the middle, by which the lobe is divided into two distinct lateral branches, each of which bears several denticulations along its base." The remarkable height of the siphonal saddle in the Koninck's figure is not considered as of any importance by Waagen, who expressly remarks (p. 256), that "Koninck's drawings vary with regard to this character as well as with regard to the breadth of this saddle, which appears sometimes broader, sometimes narrower than the first lateral." According to L. de Koninck's figure the auxiliary series consists of a single shallow lobe without denticulations and of a similarly shallow saddle, which is only partly outside the umbilical suture. To the absence of any denticulations in the auxiliary lobe I am, however, not inclined to attribute any importance. This absence is probably an accidental one. My Siberian specimens of *Meekoceras boreale*, and of the second closely allied form, show exactly the same character of the auxiliary series, as it is indicated in de Koninck's drawing, wherever the surface of the cast has suffered but slightly from weathering. The individualization and the denticulate arrangements of the auxiliary lobe are only visible in such places which have escaped injury from weathering.

Whether a nearer relationship actually exists between *M. boreale* and *M. planulatum*, cannot be decided on account of our insufficient knowledge of the characters of the latter species, but they probably belong to one and the same evolutional series.

2. Meekoceras Hodgsoni nov. sp., Pl. VI. fig. 1.

Dimensions.

Diameter of the shell		62 mm.
" " umbilicus		14 "
Height of the last volution	from the umbilical suture	29 "
	" " preceding whorl	app 21 "
Thickness of the last volution		11 "
Breadth of the siphonal area		3 "

This species is represented by a single but very well preserved specimen; it belongs to the group of *Meekoceras varians* Waagen (Ceratite formation Pl. XXIX, figs. 2—5, p. 247), and is allied to it owing to the absence of the external edges in young stages of growth, and an identical arrangement of the sutural line.

[1] *L. de Koninck*, Mémoire sur les fossiles paléozoiques, recueillis dan l'Inde, Liége, 1863, Pl. V, figs. 1, 1a, 1b, non figs. 1c, d, e) and Quarterly Journal Geol. Soc., XIX, Pl. V, figs. 1, 1a, 1b (non fig. 1c, d, e,) p. 12.

The general shape of the shell is flatly disciform, with very high, compressed whorls, and a comparatively small umbilicus. The shape of the transverse section varies considerably, according to the age of the specimen. In the relative proportion of height and thickness it remains however a true *Meekoceras*, the height surpassing the thickness of the volution even in quite young stages of growth, a height of 3 mm. corresponding to a thickness of 2 mm. It is, however, the siphonal part, which is affected by this variability; in young specimens up to a diameter of 15 mm. the transverse section is lenticular, the lateral parts are equally rounded all over, and the siphonal part passes gradually into them, being likewise evenly rounded. In the full grown specimen, however, the lateral parts are very flatly arched and separated from the flat siphonal area by sharp marginal edges. Thus a transitional form between the *rotundati* and the *biangulares* is marked by this species, to a certain extent at least, as the marginal edges are absent in the young, and are developed only in later stages of growth.

At a diameter of 18 mm. the marginal edges make their first appearance and remain perfectly distinct even in the body chamber of my specimen, as far as it is preserved. The siphonal area is perfectly flat and comparatively narrow. The umbilical margin is not distinctly defined. The lateral parts slope gradually towards the umbilical suture, but in the adolescent stage of growth, the umbilicus is surrounded by a distinct and steeply inclined, though low, umbilical wall, which in uniting with the flat lateral parts, forms a rounded umbilical margin.

The whorls overlap each other to about half of their height. The overlap of the last whorl over the preceding one amounts to less than quarter of the entire height of the former.

The sculpture is rather indistinct and delicate only. In the penultimate volution it consists of flat, barely perceptible radial undulations; in the last volution a number of narrow, rounded folds may be observed near the anterior termination. They are a little stronger developed in the middle portion of the lateral parts, where they are slightly bent falciform. The growth lines of the shell exactly correspond in their direction to these delicate but rather numerous folds. They are nearly radial, with a barely preceptible falciform bend in the middle of the lateral parts, and are turned slightly forward near the siphonal margin. Filiform striations, corresponding to the growth lines of the shell, are also noticed here and there on the internal cast.

The larger portion of the last volution consists of air chambers only, but its anterior termination is made up by the commencement of the body chamber.

Sutures.—The sutural line is entirely preserved. The siphonal lobe is broad, but not very deep. It is richly serrated below, the denticulations at the base of each of its lateral branches forming together an obliquely rounded arch. It is divided by a broad but comparatively low, angular siphonal prominence, with a central incision above.

The principal lateral lobe reaches much lower down than the siphonal one, and bears many, very regular denticulations at its base, which are arranged into a prominent arch. It is enclosed by parallel margins, remaining entire, and is as broad

as the adjoining lateral saddle. The second lateral lobe stands at the same level with the siphonal one. It is as broad as the principal lateral lobe, and the numerous denticulations at its base form an oblique arch, rising considerably higher along the external marginal border.

The siphonal saddle is rather elongated and slender, but shorter than the broad principal lateral saddle. They are both evenly rounded above. The second lateral saddle is of a very characteristic shape. It is much broader than high and strongly depressed above, its margins uniting with the flatly rounded apex in nearly obtuse edges.

The auxiliary series forms a straight line of numerous denticulations, among which, the one situated next to the umbilical suture, is larger than the rest, and followed by a deeper indentation.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 1, Coll. Diener.

Remarks.—It was stated above that *M. Hodgsoni* is a member of the group of *M. varians*, Waagen, with which it has its most remarkable characters in common, *viz.*, the development of external edges in later stages of growth only, and the particular arrangement of the auxiliary series. In the trias of the Salt Range this group is represented by two forms only, *M. varians* occurring in the lower Ceratite limestone, and *M. pulchrum*, Waagen (l. c. Pl. XXIX, figs. 1, Pl. XXVII, figs. 2, 3, p. 249) from the Ceratite marls. The species, to which *M. Hodgsoni* seems to be closer allied, is *M. pulchrum*, but they are easily distinguished by the different shape of the transverse section which is much narrower and strongly compressed in the Himálayan form, and by a remarkable detail in the sutural line, the siphonal saddle in the Salt Range species being of a distinctly phylloid outline.

3. MEEKOCERAS CF. FULGURATO, Waagen, Pl. XVIII, fig. 1.

1895. *Meekoceras fulguratum* Waagen, Salt Range fossils, Palæontologia Indica, ser. xiii, II, Fossil from the Ceratite Formation, Pl. XXX, fig. 2, a, b, c, p. 243.
1880. *Monophyllites Wetsoni*, Griesbach, Palæontological Notes on the Lower Trias of the Himálaya Records Geol. Surv. of India, XIII, Pt. 2, p. 111.

Waagen's species is unfortunately founded on a very imperfect fragment only. A similar fragment, almost perfectly identical in its outlines and sutures with Waagen's figure, is among the Himálayan collection. It was determined as *Ceratites Wetsoni*, Oppel, by Griesbach, but the true *Ceratites Wetsoni* which has been figured in my Memoir on the Cephalopoda of the Himálayan Muschelkalk (Pl. I fig. 6) is an entirely different species. As from fragments of such an imperfect state of preservation, the characters of the species to which they belong cannot be made out with certainty, I must content myself to place my fragment as "cf." with Waagen's species, in spite of the complete identity of all the characters accessible to examination.

Like Waagen's fragment, the present one consists of four air chambers. Only one side is preserved and no measurements can be taken from which the general

shape of the entire shell and the mode of involution might be guessed. Near its anterior termination the height of the fragment from the umbilical suture is 44 mm., but its thickness cannot be made out with any certainty, but the volutions are undoubtedly higher than broad. The involution seems to have been very small, as in Waagen's fragment.

There is no distinct trace of an umbilical wall or edge indicated, but the flatly arched lateral parts slope with a gradually increasing convexity towards the umbilical suture. The rounded siphonal part likewise passes into the lateral parts without distinct demarcation.

Only faint traces of broad radial undulations indicate a sculpture.

The only character, which is well preserved, both in this and in Waagen's fragment, is the sutural lines, which in both of them is almost identical, even in minor details.

The siphonal prominence is not completely preserved, but it must have been rather high and slender. The lateral branch of the siphonal lobe is provided with four denticulations. Two of them, forming the base of this branch, are more prominent. The two smaller ones are situated a little higher above, one at the base of the siphonal saddle, the other affecting the steeply inclined marginal wall of the siphonal prominence. The siphonal saddle is much contracted at its base and wider in its upper portion ; its top is narrowly rounded, the highest point being shifted a little towards the internal (umbilical) side. A similar remark applies to the two other saddles, which are also somewhat narrower below than above.

The principal lateral lobe is considerably deeper than the siphonal one. It is strongly denticulated, and this feature does not affect its base only, but reaches up along the margins as far as the base of the adjoining saddles. The most prominent denticulations, of a somewhat fingerlike shape, are those at the base of the lobe. The denticulations form together a very prominent arch and exhibit a somewhat radial arrangement. The lobe itself is broader at its base, than near its commencement.

The second lobe reaches deeper than the siphonal one, but not as deep as the principal lateral one. In the arrangement and shape of its denticulations it imitates the principal lateral lobe, although on a more reduced scale. It is also a little broader near its base than commencement, and its sides are somewhat concave.

The principal lateral saddle is scarcely broader and does not reach up much higher than the siphonal saddle. The second lateral saddle, however, is much shorter and narrower. All the saddles are comparatively slender and elongate in shape.

The auxiliary series does not form distinct lobes or saddles, but is composed of three distinct indentations, of which the one adjoining the umbilical suture is the largest, and is looked upon by Waagen as a proper saddle. It stands entirely outside the umbilical suture.

Locality and Geological position. Number of specimens examined.—Subrobustus beds, Shalshal Cliff near Rimkin Paiar encamping ground, bed 80, 1, Coll. Griesbach.

On the label accompanying the fragment, Kiunglung E. G. is marked as the locality where it has been picked up, but this is probably a mistake as in Griesbach's first report as well as in his later memoir the specimen is expressly noticed as having been collected in the Shalshal Cliff section.

4. MEEKOCERAS SP. IND. EX. AFF. PLICATILE, Waagen, Pl. XV, fig. 6.

Dimensions.

Diameter of the shell		19 mm.
" " umbilicus		7 "
Height of the last volution	from the umbilical suture	7 "
	" " preceding whorl	6 "
Thickness of the last volution		4 "

The species is represented by a small specimen consisting of air chambers only. It recalls strongly in shape and sculpture a Salt Range form which was described by Waagen as *Prionolobus plicatilis* (Ceratite formation, Pl. XXXVI, fig. 1), but as it does not show the characteristic arrangement of the auxiliary series by which *Prionolobus* differs from *Meekoceras*, I am obliged to leave it in the latter genus.

The specimen is distinguished by a tolerably large umbilicus, slowly increasing compressed whorls and by a very small involution. The whorls overlap each other to less than one third of their height only, whilst the overlap of the last volution over the preceding one amounts only to about one seventh of the entire height of the former.

The transverse section of the whorls is lanceolate, with a flattened and biangular siphonal area. Its largest transverse diameter coincides with the umbilical margin. The latter forms a distinct but slightly rounded edge and is separated from the umbilical suture by a vertical wall. The lateral parts converge regularly towards the siphonal margins in shape of scarcely arched planes. The siphonal part is decidedly flattened; its breadth is 2 mm. at the anterior termination of the last volution. The marginal edges of the siphonal part are sharp but not provided with elevated ridges.

The sculpture is identical with the one described of *Prionolobus plicatilis*, Waagen. It consists of very numerous, delicate, filiform striæ of very irregular strength which are radially arranged confined to the vicinity of the umbilical margin, dying out gradually towards the upper portion of the lateral parts.

Sutures.—The sutures are still nearly goniatitic, in agreement with the small size of the specimen. Only at the base of the principal lateral lobe faint traces of serration may be seen by means of a strong lens.

The siphonal lobe is rather short and narrow, and is situated entirely on the flattened siphonal part of the shell. A low, angular siphonal prominence divides it into two lateral branches, with apparently rounded-off terminations. The two lateral lobes converge slightly towards their base. The second lateral lobe stands at a lower level than the siphonal lobe. The siphonal and principal lateral saddles

are nearly of equal size and are evenly rounded above, with their borders slightly converging towards the top. The second lateral saddle is comparatively low and forms a broadly rounded arch. A small rounded auxiliary lobe follows outside the umbilical suture.

As in *Prionolobus plicatilis*, Waagen, the septa are very closely arranged.

Locality and Geological position. Number of specimens examined.—Otoceras beds, south of Kuling, Spiti, 1, Coll. Griesbach.

Remarks.—The similarity to *Prionolobus plicatilis* Waag., in shape and sculpture is so striking, that I believe an intimate relationship may indeed exist between these two species. *P. plicatilis* is quoted by Waagen as derived from the lower Ceratite limestone, *i.e.*, from a horizon, which is *praeter propter* homotaxial with the Himálayan Otoceras beds. It is quite isolated among the other forms of the Salt Range, which have been united by Waagen in the genus *Prionolobus*, nor is its auxiliary series very characteristic. As pointed out by Waagen, the latter consists of the three denticulations only on the same level. But for this character it may as well be placed among Waagen' genus *Gyronites* or among *Meekoceras* if the range given to this genus in the present memoir is accepted.

Differences between the two species exist in the absence of an umbilical edge and in the somewhat higher position of the largest transverse diameter in *Prionolobus plicatilis* as well as in minor details of the sutural line. But they are of small importance in comparison with the close affinities which the two forms exhibit in all their most conspicuous characters.

5. Meekoceras sp. ind., Pl. VII, fig. 10 *a*, *b*.

Dimensions.

Diameter of the shell		23 mm.
„ „ „ umbilicus		1 „
Height of the last volution	from the umbilical suture	13·5 „
	„ preceding whorl	9 „
Thickness of the last volution		4 „

This species is represented by a single small specimen only, and unfortunately not the slightest trace of sutures is visible. Thus I must not only abstain from giving it a specific designation, but also must leave its generic position doubtful, although the general outline agrees best with those of a *Meekoceras*. I am, however, obliged to confess, that future examinations of a more perfect material may lead to very different results, as the species may perhaps belong to *Clypites* or to *Kymatites*, or one of their allies.

Among the known species of *Meekoceras*, *M. radiosum*, Waagen (Ceratite formation, Pl. XXXVI, fig. 2, p. 257), shows a distant similarity to the specimen under description. The latter, however, is distinguished by its much higher and strongly compressed volutions and a different outline of the cross section. The whorls overlap each other almost entirely, the umbilicus being extremely narrow. The overlap of the last whorl over the preceding one amounts to about one third of the entire height of the former.

The transverse section of the whorls is a long oval. The largest transverse diameter corresponds to the centre line of the lateral parts, which slope from this point in a very flatly arched regular curve towards the umbilical suture and with a similar regularity towards the siphonal margin. In quite young stages no umbilical edge nor wall are present, but whether they are developed in later stages of growth cannot be decided from this imperfect specimen. In the adolescent stage it is distinctly biangular. Near the commencement of the last volution two sharp external edges may still be seen, but towards the anterior termination of this volution they become gradually rounded off. Thus our species would belong to the group of the *semirotundati*, Waagen. So long as the marginal edges are distinctly developed, the siphonal part is flattened, but in later stages of growth it becomes moderately rounded.

The volutions are very strongly compressed, being three times as high as broad. The internal cast does not show a trace of sculpture. The ornamentation of the shell consists of very delicate, falciform growth lines, which in my fruitless attempts to render the sutural lines visible, were almost completely destroyed.

Locality and Geological position. Number of specimens examined.—Otoceras beds, south of Kuling, Spiti, 1, Coll. Griesbach).

Subgenus: KONINCKITES, Waagen.

1895. *Koninckites*, Waagen, Salt Range fossils, Pal. Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 258.

6. (1) KONINCKITES VIDARBHA nov. sp., Pl. VII. fig. 8, 9.

Dimensions.

		Fig. 9.
Diameter of the shell		23 mm.
" " " umbilicus		4·5 "
Height of the last volution	from the umbilical suture	12 "
	" preceding whorl	9 "
Thickness of the last volution		5 "

I consider the single form from the Shalshal Cliff, Pl. X. fig. 9, to be the type specimen of this species in which the sutural line is preserved, although it only represents the inner volutions of a larger individual, being entirely composed of air chambers. Besides this one, I include a rather large number of specimens from the Otoceras beds of the Lissar Valley in this species. They are almost all provided with body chamber, but their sutural lines cannot be made out. In the specimen, fig. 8, only the inner volutions are visible on one side, the outer volution being partially broken off. These inner volutions agree in shape and sculpture so perfectly with the specimen, Pl. X, fig. 9, that I think I am justified in uniting both in one and the same species.

Dr. Waagen has adopted the name *Koninckites* for such genera of *Meekoceratidæ* from the Salt Range as are distinguished by the individuality of one auxiliary lobe and saddle among their auxiliary series. This species belongs

to this group of forms, to which, however, a subgeneric rank is due in my opinion. Judging from the outlines of its siphonal part it may be included among the *Semirotundati*, because it is provided with sharp external edges in the adolescent stage, which disappear in the full-grown individuals.

Koninckites Vidarbha is distinguished by very narrow, compressed whorls which overlap each other to a very considerable extent, leaving only a small umbilicus open. The involution even increases in later stages of growth, so much so that in a full grown individual of a diameter of about 40 mm. the diameter of the umbilicus is but very little larger than in the type specimen, fig. 9, which corresponds to a diameter of the shell of 23 mm. only. The overlap of the last whorl over the penultimate one amounts to one quarter of the entire height of the former.

The transverse section is a long oval and very much higher than broad. The largest transverse diameter is situated near the middle of the height of the volutions. The lateral parts slope in a moderate and perfectly regular curve from the most inflated point towards both the umbilical margin and the siphonal area. The umbilical margin is distinctly defined, forming an obtusely rounded-off edge, from which a low but steep wall descends to the umbilical suture. The siphonal part is very narrow and quite flat in young individuals, but becomes considerably broader in comparison with the height and thickness of the volution in full-grown specimens At the same time the external edges become gradually rounded off, but the siphonal area itself remains always flat and is not arched at all.

The sculpture is very characteristic and strongly recalls the sculpture in young individuals of *Meekoceras* (*Beyrichites?*) *Ragazzonii*, v. Mojsisovics (Cephalopoden der mediterranen Triasprovinz, Pl. LXI, fig. 5, p. 217). If one compares this figure with the drawing of our type specimen, the similarity is a most striking one, but this remark applies only to young individuals of *Meekoceras Ragazzonii*, because in the full-grown stage (Pl. XXXIX, fig. 3) this Alpine species develops distinct nodes, whereas our species does not change its sculpture in advanced age. The sculpture consists of numerous low, falciform folds, starting a little outside the umbilical margin and gradually enlarging towards the siphonal margin, near which they die out. Their greatest strength is developed near the middle portion of the lateral parts, but they are neither of even strength nor arranged at a perfectly regular distance. They die out before reaching the external edges and none of them crosses the siphonal part.

In the type specimen, fig. 9, the shell is partly preserved. Its ornamentation consists of very numerous growth lines, following the direction of the folds. Near the middle portion of the lateral parts they are falciform with forward turned convexity, whereas they describe a strongly forward bent curve near the siphonal margin.

Sutures.—The sutures are well preserved in the type specimen (Pl. VII, fig. 9). They are almost perfectly identical with the sutural line of *Koninckites sibiricus*, Mojs. (Arktische Triasfaunen, Pl. XI, fig. 6, p. 85).

The siphonal lobe is short and very simple. It is not entirely restricted to the

siphonal area but extends beyond the latter on the lateral parts. It is divided by a comparatively short, angular siphonal prominence into two branches, each of which terminates in a single either sharp or rounded-off point. This simple development of the siphonal lobe is one of the most characteristic features of the sutural line, which our species has in common with *Koninckites sibiricus* and with *Koninckites impressus*, Waagen (Ceratite Formation, Pl. XXXV, fig. 6, p. 263), whereas no other congeneric form of the Salt Range trias exhibits this remarkable peculiarity.

All the rest of the lobes are distinctly denticulated. At the base of the principal lateral lobe the denticulations are even sufficiently strongly developed to be visible with the naked eye. The principal lateral lobe is of the same width as the adjoining saddle. The second lateral lobe is on the same level as the siphonal and the auxiliary lobes. There are also two distinctly individualised auxiliary lobes separated by a semicircular auxiliary saddle. The commencement of a second auxiliary saddle may be seen outside the umbilical suture. The siphonal saddle is slender and elongated, but shorter than the principal lateral one, which is the largest of all and moderately broad. The second lateral saddle is broadly rounded above.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 1, Coll. Diener; south of Dharma No. XI, Lissar Valley, Johár 5 Coll. Griesbach.

Remarks.—This species appears to be closely allied to *Koninckites sibiricus*, Mojs., from the Olonek beds of north-eastern Siberia. The sutural line is almost perfectly identical, which is combined with a remarkable similarity of sculpture. But still sufficiently distinct characters may be made out, to make specific distinction easy. The umbilicus is still narrower and the volutions are considerably broader in the Siberian species. The overlap of the last whorl over the preceding one is also larger, amounting to two fifths of the entire height of the former. Last, but not least, the external edges persist in *K. sibiricus* even in the full-grown individuals and distinctly separate the remarkably broad siphonal area from the flat but slightly convex lateral parts.

The species may be easily distinguised from *K. impressus*, Waagen, from the lower Ceratite limestone of the Salt Range, by its much narrower umbilicus and by its comparatively strong sculpture, entirely absent in the Salt Range form, with which it is allied owing to the peculiar development of its siphonal lobe.

7. (2) Koninckites Yudishthira nov. sp., Pl. XXII, fig. 1.

Dimensions.

Diameter of the shell		142	mm.
" " " umbilicus		31	"
Height of the last volution { from the umbilical suture	app.	68	"
Height of the last volution { " " preceding whorl		53	"
Thickness of the last volution	app.	32	"

This is a large and very remarkable species, closely allied to *K. Lyellianus*, de Kon., and represented by a fairly well preserved specimen. In general shape it is

disciform, with rapidly increasing whorls, with moderately large umbilicus. The whorls overlap each other to one fifth of their height, and the overlap of the last volution over the preceding one amounts to but little more than one fifth of the entire height of the former.

The transverse section of the whorls is a long oval. The largest transverse diameter nearly coincides with the centre line of the lateral parts. The latter are flatly convex and slope in a regular and even curve towards the siphonal margin as well as towards the umbilical one. The siphonal side is rounded all over and passes quite gradually into the lateral parts, without any distinct demarcation. The umbilicus is surrounded by a high and vertical umbilical wall, which joins the lateral parts in a narrowly rounded off edge.

The internal cast is perfectly smooth, without trace of sculpture. Of the shell nothing is preserved.

Sutures.—The sutural line is known with the exception of the siphonal prominence which I have failed to disclose.

The siphonal lobe is very broad and comparatively deep, and on the same level as the second lateral one. Its lateral branches are strongly denticulated, and this character is not confined only to the base of the lobe, but may be seen also on the interior border. Two of the denticulations, adjoining the siphonal saddle, are at a higher level than the rest. The principal lateral lobe is deep and its borders are slightly concave; converging towards the base of the saddles and still more strongly downwards to the bottom, which terminates in a large median, pointed indentation. It is flanked by three or four smaller denticulations on each side. The second lateral lobe is remarkably broad. Its denticulations form together an obliquely rounded arch, being cut off diagonally along the external margin, as in many species of *Proptychites*. The denticulations affecting this diagonally sloping external border are much more numerous and smaller than those at the base of the lobe, which terminates in three large, sharply pointed denticulations, all situated on one and the same level.

The siphonal saddle is slender and slightly contracted at its base, narrowly rounded above, and not as high as the principal lateral saddle. The principal lateral saddle is broader and very oblique in outline. It is rather narrowly but not symmetrically rounded above. The second lateral saddle is skew-shaped and broadly rounded above. The first auxiliary lobe, following this saddle, imitates in outlines the second lateral lobe almost to the minutest details, but on a reduced scale, being considerably smaller than the former. It is followed by a large auxiliary saddle, which, although smaller and narrower than the second lateral saddle, is as distinctly individualized. It is bordered by parallel sides and symmetrically rounded above. It is divided into two irregular portions by the umbilical margin, the larger portion being situated on the lateral part of the shell. On the umbilical wall two elongated and sharply pointed denticulations are still visible, belonging to a second auxiliary lobe, which is quite distinctly separated from the first auxiliary saddle.

Rather less than half of the last volution in the specimens described forms part of the body chamber.

Locality and Geological position. Number of specimens examined.—Subrobustus beds, south-east of Muth, Spiti, 1, Coll. Griesbach.

Remarks.—This species seems to be closely allied to ***Koninckites lyellianus***, Kon.,[1] and to *K. **gigas***, Waagen (Ceratite Formation, Pl. XXXI, fig. 2, p. 266). It is distinguished from them by its more rapidly increasing volutions and by a smaller umbilicus. Its siphonal part is rounded as in *K. gigas*. Our specimen shows the greatest resemblance in its sutures to *K. gigas*, especially in the arrangement of the auxiliary series. The auxiliary series of *K. lyellianus* is only imperfectly known. In de Koninck's type specimen, however, a distinct auxiliary saddle is clearly visible outside the umbilical margin. I believe, therefore, that an intimate connection exists between *K. Yudishthira* and these two Salt Range forms, although the differences in the size of the umbilicus and in the minor details of the sutural lines make a specific distinction between them easy enough.

Subgenus: KINGITES, Waagen.

1896. *Kingites*, Waagen, Salt Range fossils, Pal. Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 230.

8. (1) KINGITES VARAHA, Diener, Pl. VI, fig. 2, Pl. VII, fig. 6.

1895. *Kingites Varaha*, Diener, Mittheilungen uber triadische Cephalopodenfaunen von der Ussuri-Bucht und der Insel Russkij in der ostsibirischem Küstenprovinz, Sitzungsber. kais Akad. d. Wiss. Wien, math. nat. Cl., CIV, pt. i, 1895, p. 270.

Dimensions.

Diameter of the shell		60 mm.
" " " umbilicus		10 "
Height of the last volution	from the umbilical suture	32 "
	" " preceding whorl	app. 19 "
Thickness of the last volution		14 "

This species belongs to the group of ***Meekoceras Keyserlingi***, v. Mojsisovics, (Arktische Triasfaunen, Pl. X, fig. 13, 14, 15, p. 81), which is distinguished by an auxiliary series, consisting of a straight row of denticulations of irregular strength and arranged as to form several less deeply incised groups, which may be considered as rudimentary saddles. Waagen introduced the name ***Kingites*** for this group of forms, characterized by a rudimentary development of their auxiliary saddle. According to my introductory remarks on ***Meekoceras*** I shall use this name as a subgeneric designation.

Kingites Varaha belongs to the biangular forms like *K. **minutus***, Waagen, whereas all the rest of the hitherto described congeneric species are provided with a rounded siphonal part. In the body chamber of full-grown individuals only the

[1] *L. de Koninck*, Quart. Journ. Geol. Soc., XIX, 12, Pl. VI, fig. 1; *W. Waagen*, Fossils from the Ceratite Formation, Pl. XXX, fig. 3, p. 270.

external edges become slightly rounded, but the siphonal area remains always flat and is distinctly separated from the lateral parts.

K. Varaha is distinguished by very high, compressed whorls and by a narrow umbilicus, which in this specimen seems to widen so considerably towards the anterior termination of the body chamber that it leaves the normal spiral. The height of the transverse section is more than twice its breadth. The largest transverse diameter is situated above the lower third of the height of the lateral parts. The latter are very flatly convex and separated from the umbilical suture by a distinct umbilical wall. The umbilical margin is rounded in the adolescent stage, but gradually passes into a very obtuse edge in later stages of growth.

The surface of the cast is without distinct sculpture. Faint traces of falciform striæ are, however, indicated in some places, especially near the vicinity of the siphonal area, which is crossed by these filiform striæ in straight lines.

A little more than one half of the last volution forms part of the body chamber in one of the two specimens.

Suture.—The larger portion of the broad siphonal lobe is situated on the lateral parts and is at the same level as the second lateral lobe. It is provided with numerous denticulations and is divided by a high siphonal prominence which is likewise denticulated. The lateral lobes are distinctly serrated below. The siphonal saddle is lower than the principal lateral one. Both are slender and elongated, whereas the second lateral saddle is broad and clumsy. But it is distinctly individualized and does not merge into the auxiliary series as in *Kingites Keyserlingi*, Moja. To dissolve the auxiliary series into its different elements seems impossible, although larger denticulations alternate irregularly with smaller ones. A first auxiliary lobe may perhaps be formed by a number of very small denticulations adjoining the second lateral saddle.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground, 1, Coll. Diener; South of Kuling, Spiti, 1, Coll. Griesbach.

Remarks.—Kingites Varaha is one of the most common species in the lower trias of the Russkij island and of the Ussuri district of the Siberian littoral province. The specimens, one of which will be figured in the Memoires du comite geologique de la Russie, XIV, No. 3, Pl. 1, fig. 2, are exactly identical with the Himalayan type specimens.

Kingites minutus.—The only congeneric forms from the Salt Range, with biangular outlines, described by Waagen (Ceratite Formation, Pl. XXXVI, fig. 6, 7, p. 235), differ so completely from this species that I may abstain from entering into any further details. Among the species with a rounded siphonal area *Kingites lens*, Waagen (Pl. XXVI, fig. 4, p. 232), exhibits a distant similarity to *K. Varaha* in the mode of its involution and in the general character of the sutural line, but differs by a narrower umbilicus, a moderately convex umbilical margin, and by a very deep siphonal lobe.

Subgenus: ASPIDITES, Waagen.

1895. *Aspidites*, Waagen, Salt Range fossils, Palæontologia Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 215.

9. (1.) ASPIDITES SUPERBUS, Waag. var. Pl. XXI.

1895. *Aspidites superbus*, Waagen, Ceratite Formation, Pl. XXIII, Pl. XXIV, fig. 1, p. 218.

Dimensions.

Diameter of the shell		278 mm.
" " " umbilicus		12 "
Height of the last volution	from the umbilical suture	156 "
	" " preceding whorl	107 "
Thickness of the last volution		68 "

Among Griesbach's collection from the subrobustus beds of Muth in Spiti there is a very large specimen, which is almost identical with Waagen's most characteristic species of the subgenus *Aspidites*. Although this specimen is partly weather-worn and has entirely lost its shell it is sufficiently well preserved to show all the remarkable characters of this species, especially the very conspicuous and complicated sutural line.

It is largely disciform with high compressed whorls and a very small umbilicus. The overlap of the last volution over the preceding one amounts to less than one third of the entire height of the former.

The transverse section is said to be lancet-shaped according to Waagen. It is more than twice as high as broad. The largest transverse diameter corresponds approximately to the limit of the lower and middle third of the height of the volution; from this point the lateral parts slope very gradually towards the umbilical margin, which is not distinctly defined, the lateral parts bending down to the umbilical suture rather suddenly. The lateral parts are somewhat flatly convex and converge gradually towards the moderately rounded siphonal area, without forming distinct edges.

No trace of sculpture is visible on the surface of the cast, which seems to have been perfectly smooth.

About two fifths of the last volution form part of the body chamber. A diameter of the shell of 192 mm. corresponds to the last septum, so that the specimen is exceeded in size by Waagen's type specimen, which, with a diameter of 240 mm., is entirely made up of air chambers.

Sutures.—The sutural line is very characteristic on account of the complicated arrangement of the auxiliary series, and is very well preserved.

The broad siphonal lobe is provided with a moderately high pyramid-shaped denticulated siphonal prominence. At the base of each of the lateral branches of this lobe are two very large denticulations with sharp points. Adjoining them an equally large indentation affects the base of the siphonal prominence, but is situated a little higher. There is a smaller one near the base of the siphonal saddle. The principal lateral lobe is deep and broad, with slightly concave borders, which are crenulated. The strong and sharply pointed, finger-like denticulations at the base

of this lobe are arranged as a prominent arch. The second lateral lobe is as broad as the principal one but considerably shorter. Its denticulations are arranged in a slightly oblique arch. A group of stronger pointed denticulations affects the external margin, whereas a very large and broad denticulation terminating in small crenulations is situated at the umbilical (internal) side of its base.

The siphonal saddle is somewhat contracted below and obliquely rounded above. The two lateral saddles are more oblique. Especially in the principal lateral saddle the highest point is decidedly shifted towards the internal side. This saddle reaches somewhat higher up than the siphonal one and is also narrowly rounded above. The second lateral saddle is considerably shorter, with nearly parallel borders and with obliquely rounded apex.

The auxiliary series begins with a broad, distinctly individualised auxiliary lobe, which, although shorter than the second lateral lobe, is provided with stronger finger-like denticulations. Three very large ones are arranged along its internal side, whereas the smaller crenulations are restricted to its external margin. Next to this lobe follows a narrow elongated saddle with parallel sides and a rounded off apex. It is bordered at its umbilical side by a second distinctly individualised lobe, which is considerably shorter and narrower than the first auxiliary lobe. It is tricuspidate, but one of its denticulations is much smaller than the other two. Then follows an elongated saddle of the same shape as the first, and a rounded lobe. The next two lobes and saddles are very small and rudimentary only. The lobes are pointed and narrow. The first saddle is broad, with a depressed apex and parallel borders; the second saddle is conical. A third saddle is divided into two portions by the umbilical suture.

The sutural line is perfectly identical with the one in Waagen's type specimen of *A. superbus*, with the single exception of the very last element of the auxiliary series. In Waagen's type specimen the third auxiliary lobe is followed by a broad flattened saddle with an adjoining bipartite lobe, whereas in this specimen it is followed by the three small rudimentary saddles with two pointed lobes between them.

Taking into consideration the extreme variability of the auxiliary series in similar forms with an equally complicated sutural line—*Sedenstroemia Mojsisovicsi* for instance, in which the two sides of the same specimen even are asymmetrical—this small difference can scarcely be considered of sufficient importance for a specific distinction of the two specimens. I think I have shown that this specimen is a variety of *Aspidites superbus*, from which, in my opinion, it ought not to be specifically separated.

Locality and Geological position. Number of specimens examined.—Sub-robustus beds. S.E. of Muth, Spiti 1, Coll. Griesbach.

Genus: LECANITES, v. Mojsisovics.

1882. *Lecanites*, E. v. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlungen k. k. geol. Reichs-Anstalt, X, p. 199.
1895. *Lecanites*, Waagen, Salt Range fossils, Pal. Indica, ser. xiii, II, Fossils from the Ceratite Formation, p. 275.

Prof. Waagen has demonstrated the close relationship of *Lecanites* to the *Meekoceratidæ* in so convincing a manner that I follow his lead in placing this genus in the subfamily of the *Meekoceratinæ*.

Whereas *Lecanites* is largely represented in the Salt Range, only two specimens have been obtained from the Himálayan trias. One of them consists of a very imperfect fragment only, which just suffices to establish its relationship to this genus. The other is the representative of an isolated species, differing from all the rest of the hitherto described *Lecanites* by its narrow umbilicus and higher volutions, which overlap each other to about two thirds of their height.

Dr. Waagen in his diagnosis of the genus mentions "a large umbilicus and whorls which only very slightly overlap each other," as generic characters. In accordance with my views expressed in the introduction to *Meekoceras* I do not consider the height of the volutions and their overlap alone as being of sufficient importance to create a new genus or even subgenus only for the reception of the present species.

1. Lecanites Sisupala, nov. sp. Pl. XXIII, fig. 8.

1880. *Norites planulatus var.* Griesbach, Palæontological Notes on the Lower Trias of the Himálayas. Records, Geol. Surv. of India, XIII, p. 100.

Dimensions.

Diameter of the shell		33 mm.
" " " umbilicus		11 "
Height of the last volution	from the umbilical suture	17 "
	" " preceding whorl	13·6 "
Thickness of the last volution		10 "
Breadth of the siphonal area		4·5 "

This specimen has been identified by Griesbach with *Meekoceras planulatum*, de Koninck (Quart. Journ. Geol. Soc., XIX, Pl. V, fig. 1), but the sutural line, which is still perfectly goniatitic at a diameter of 33 mm., forbids this identification, in spite of a remarkable similarity in general outlines.

The external shape of this species is that of a moderately involute *Meekoceras* with a biangular siphonal part. The slowly increasing whorls are considerably higher than broad and overlap each other to about two thirds of their height. The diameter of the umbilicus is smaller than the height of the last volution by one third of the latter, a proportion which is not met with in any other species of *Lecanites*. The overlap of the last whorl over the preceding one amounts to a little less than three quarters of the entire height of the former.

The largest transverse diameter coincides with the umbilical margin, which forms a sharp edge, with a comparatively high and vertical wall. The lateral parts converge from the umbilical edge regularly towards the siphonal part, forming planes, barely convex at all. The siphonal part is quite flat and biangular, with sharp marginal edges, persisting in the full-grown stage. The breadth of the siphonal area increases considerably in the last volution and towards the anterior termination of the body chamber.

The sculpture of the internal cast is very indistinct. Faint traces of radial folds are indicated in the vicinity of the umbilical margin, as in *Lecanites undatus*, Waagen (*loc. cit.* Pl. XXXVIII, fig. 1), but they seem to be narrower and are only developed in the last third portion of the ultimate volution. The remaining part of the last whorl is perfectly smooth.

Not a trace of the shell substance is preserved.

Rather more than one third of the last volution forms part of the body chamber.

Sutures.—I have not succeeded in developing the siphonal lobe completely. The rest of the sutural elements, which are all perfectly goniatitic, are very well preserved.

The saddles are all large at their base and strongly converge upwards, with narrowly and symmetrically rounded tops. The siphonal saddle is the largest, exceeding in size the principal lateral saddle. The principal lateral lobe is remarkably deep. The broad and flat auxiliary lobe is divided by the umbilical edge. A low auxiliary saddle commences outside the umbilical suture.

The vertical projection of the periphery of the penultimate whorl touches the external portion of the second lateral saddle of the last volution.

Locality and Geological position. Number of specimens examined.—Sub robustus beds. Shalshal Cliff, near Rimkin Paiar encamping ground 1, Coll. Griesbach. The specimen is derived from bed 89 of Griesbach's section.

Remarks.—This species appears to be quite isolated among the congeneric forms. As regards its indistinct sculpture and the biangular nature of its siphonal part, it recalls the group of *Lecanites psilogyrus*, Waagen, but the difference in the size of the umbilicus and of the involution forbid any closer comparison.

2. Lecanites sp. ind. Pl. XXIII, fig. 2.

Only a very imperfect fragment of this species exists, comprising a part of the last septum and the larger portion of the body chamber. It is too imperfect to allow of measurement, from which the relative dimensions of the specimen might be calculated. The diameter of the umbilicus was certainly considerably larger than the height of the last volution. The whorls increase very slowly and overlap each other to a small extent only.

The transverse section is a long oval and considerably higher than broad. The lateral parts are very regularly but flatly convex. The flattened siphonal part has distinct marginal ridges. The umbilical margin is less distinctly marked, and forms a very obtuse edge, with the low and moderately inclined umbilical wall.

The surface of the cast is covered with numerous, delicate falciform striæ, at irregular intervals. Most of these striæ are only visible when the specimen is turned towards the light.

Sutures.—Only the siphonal and principal lateral lobes with the adjoining saddles are preserved in the last septum. They are perfectly goniatitic, and it is

evident from the state of preservation of the cast, in which the delicate ornamentation is developed, that their goniatitic character is original and not due to weathering. The systematic position of the specimen in the genus *Lecanites* seems therefore to be justified.

Locality and Geological position. Number of specimens examined.—Subrobustus beds. Bambanag Cliffs, Girthi valley, Johar 1, Coll. Diener.

Remarks.—The specimen is too imperfect to permit comparison with similar forms from the Salt Range.

Genus: PRIONOLOBUS, Waagen.

PRIONOLOBUS (?) SP. IND. Pl. VII, fig. 14.

The genus *Prionolobus* was introduced by Waagen for those forms of *Meekoceratidæ* in which the auxiliary series consists of a large number of fine denticulations, which are all on the same level and in a straight line.

It is with great hesitation only that I venture to include this imperfect fragment in this genus. In shape it is very similar to the typical form of *Ophiceras tibeticum*, Griesb., but although the surface of the cast is perfectly well preserved, there is not the slightest trace of spiral striations visible on it. A conspicuous difference in the arrangement of the sutural line consists in the position of the second lateral saddle. The latter is completely outside the umbilical margin, which is never the case in any of the specimens of *O. tibeticum*, in which the second lateral saddle is always divided into two portions by the umbilical edge. The auxiliary lobe forms a long row of delicate crenulations, which are all on the same level. But this character is frequently met with in *Ophiceras* also, and in some species of this genus (*O. Sakuntala* for instance) transitional stages exist from a regularly rounded off auxiliary lobe to a straight, prionitic, umbilical lobe. Thus this fragment may turn out after all to belong to *Ophiceras*, and it is only provisionally and not without reservation that I have attributed it to Waagen's new genus.

The fragment itself scarcely needs a detailed description as, with the exception of the above characters, it is very similar to the typical form of *Ophiceras tibeticum*.

Its transverse section is decidedly cordiform. To a height of 13 mm. corresponds a breadth of 11 mm. near the anterior aperture of the last volution. The largest transverse diameter coincides with the distinctly marked but obtusely rounded off umbilical edge. The siphonal part is moderately rounded and passes gradually into the flat lateral parts. The umbilical wall is rather high and steeply inclined.

The sculpture consists of very numerous delicate filiform costæ of a falciform direction.

Sutures.—Identical with the sutures of *O. tibeticum*, with the exception of the different position of the second lateral saddle. The central incision in the apex of the siphonal prominence is very distinctly marked. Each of the lateral branches of the siphonal lobe is provided with a bicuspidate termination.

The umbilical lobe is prionitic, and consists of very numerous delicate denticulations of equal size, which form together a straight line as in the typical species of Waagen's genus *Prionolobus*.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Kiunglung encamping ground, S.W. of Niti Pass 1, Coll. Griesbach.

Remarks.—It was stated in the introduction that the relationship of this fragment to *Prionolobus* is very doubtful. A true representative of this genus is perhaps *Ammonites peregrinus*, Beyrich,[1] from Ladakh, which had been found by the missionary Prochnow in beds of unknown age. It may be after all a permian and not a triassic species. Similar forms are quoted by E. v. Mojsisovics[2] from the permian marbles of Woabjilga on the road to the Karakorum Pass, which were found by Stoliczka during his last travels with the Yarkand Mission.[3]

Subfamily: *HUNGARITINÆ*, mihi.

Genus: HUNGARITES, v. Mojsisovics.

1882. *Hungarites*, E. v. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlungen k. k. geol. Reichs-Anstalt, X, p. 221.

Hugarites sp. ind. Pl. XXIII, fig. 5.

Whereas the subgenus *Otoceras*, Griesbach, is largely represented in the lowest trias of the Himálayas, only a single fragment of a true *Hungarites* has been found among the exceedingly rich collections from the Otoceras beds of the Shalshal Cliff.

It is the more interesting, because in spite of its fragmentary state it proves in the most convincing manner the intimate relationship of *Hungarites* with *Otoceras*. In general outlines it agrees perfectly with a medium-sized *Otoceras Woodwardi*, in which the ear-like ridges near the umbilical margin have not yet been developed, and the only remarkable difference from *Otoceras* is in the denticulate development of the siphonal lobe, which is bifid in *Otoceras*, whereas each of its lateral branches is denticulate in *Hungarites*.

The fragment is composed of a portion of the body chamber and the five last septa. The transverse section is helmet-shaped, a thickness of 18 mm. corresponds to a height of 25·5 mm. The largest transverse diameter is situated within the lower third of the height of the volution. The lateral parts are flatly convex. The umbilical margin, though rounded off, is distinctly marked. The low umbilical wall slopes very steeply towards the umbilical suture.

An obtuse edge marks the siphonal margin. From this edge the siphonal part rises in an oblique plane towards the sharp median keel.

[1] *E. Beyrich*, Monatsber. Akad. d. Wiss. Berlin, 1867, p. 61; and "Ueber einige cephalopoden aus dem Muschelkalk der Alpen und über verwandte Arten." Abhandlgn. konigl. Akad. d. Wiss. Berlin, 1866, p. 123, Pl. V, fig. 4.

[2] *E. v. Mojsisovics*, in *Suess*, Beiträge, zur Stratigraphie Central-Asiens, Denkschr. kais Akad, d. Wiss. Wien, math. nat. Cl., LXI, 1894, p. 30.

[3] *W. T. Blanford*, Scientific Results of the second Yarkand Mission. Calcutta, 1878.

Not a trace of shell is preserved in this fragment. The surface of the internal cast is quite smooth.

Sutures.—The vertical projection of the periphery of the penultimate whorl coincides with the inner margin of the second lateral saddle.

The siphonal lobe is asymmetrical. In the five septa of this fragment, which are placed very close to each other, the lateral branches are provided with a tricuspidate termination on the one and with a bicuspidate termination on the other side of the median edge. The low, broadly rounded siphonal prominence is perfectly identical with the siphonal prominence in the Himálayan species of *Otoceras*. The narrow and elongated principal lateral lobe shows a tripartite arrangement of its denticulations, which are strongly developed and finger like. A small crenulation is situated somewhat higher up at the base of the siphonal saddle. The second lateral lobe is bipartite, but the inner denticulation, adjoining the second lateral saddle, bears a few very small indentations below. The siphonal saddle is narrow and slender, symmetrically rounded above, and considerably shorter than the very large principal lateral saddle. The latter is very oblique, with a vertical inner border The second lateral and the first auxiliary saddles are of normal shape and symmetrically rounded. The first auxiliary lobe is narrowly rounded below, the second, which corresponds to the umbilical margin, is pointed. A second auxiliary saddle extends across the umbilical wall.

The siphonal saddle is divided by the marginal ridge.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff, near Rimkin Paiar encamping ground 1, Coll. Diener.

Remarks.—This species is very closely allied to the genus *Otoceras*, but its auxiliary series is at a slightly lower level of development than in any of the forms which I shall have to describe in the next chapter. The asymmetric arrangement of the siphonal lobe is very characteristic for a form liable to rapid variability, as are all the species of *Otoceras* from the Himálayan lower trias.

There is no *Hungarites* from the Alpine trias or from the triassic beds of Mora d'Ebro in Spain, with which this one might be compared. The same remark applies to the Arctic *Hungarites triformis* from the Siberian Muschelkalk.

The only species, whose sutural line shows a distant similarity to the present one, is *Hungarites djoulfensis*, Abich,[1] the geologically oldest representative of the genus from the permian Otoceras beds of Julfa in Armenia. It is provided with two auxiliary lobes and saddles, and the character of the principal lateral lobe as well as that of the adjoining strongly oblique lateral saddle somewhat recall our specimen.

Subgenus: OTOCERAS, Griesbach.

1880. *Otoceras*, Griesbach, Palæontological Notes on the Lower Trias of the Himálayas, Records, Geol. Survey of India, XIII, p. 106.

1882. *Otoceras*, E. v. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlgn. k. k. geol. Reichs-Anstalt, X, p. 231.

[1] *H. Abich*, Geologische Forschungen in den kaukasischen Ländern. I. Eine Bergkalk fauna aus der Araxesenge bei Djoulfa in Armenien, Wien, 1878, p. 11, Pl. II, fig. 1, XI, fig. 20.

The genus *Otoceras* was created in 1880 by C. L. Griesbach for some of the most conspicuous and interesting forms from the lower trias of the Himálayas, discovered by him during his first campaign in the Niti district. He recognised the intimate relationship of *Otoceras* with *Hungarites*, a genus which had been proposed by E. v. Mojsisovics[1] almost at the same time, for a few species from the Mediterranean trias[1] which are distinguished by a ceratitic lobe line, a sharp siphonal keel and marginal ridges. This relationship seemed such a close one to v. Mojsisovics, that in his Memoir on the Cephalapoda of the Mediterranean triassic province he considered *Otoceras* as only a subgenus of *Hungarites*. According to him the double pointed siphonal lobe in *Ctoceras* is the sole difference of subgeneric importance, while he attributes only a specific value to the strange elevation of the umbilical margin which is so characteristic in the Himálayan forms of *Otoceras*.

As regards the systematical position of *Otoceras* I prefer to follow the views of E. v. Mojsisovics, as its intimate relationship with *Hungarites* does not seem to justify the establishment of an independent genus. It shares with *Hungarites* the ceratitic sutural line, the shape and mode of involution, and the sharp median keel of the siphonal part, which is bordered by similar marginal ridges. This tripartite character of the siphonal part is particularly well developed in the young and adolescent stages of growth. I have been able to trace it in young specimens of *Otoceras Woodwardi* with a diameter of the shell of 5 mm. only. In full-grown individuals, however, only a faint indication of a three-edged termination of the siphonal area is visible, as has already been remarked by Griesbach (*loc. cit.*, p. 106), and the sharp, knife-shaped, median edge only remains. In two of the largest specimens of *O. Woodwardi* every trace of the marginal ridges is completely lost in the body chamber (Pl. II, Pl. V, fig. 1), and the uninterrupted lateral parts join in graceful curves in the sharp median keel. In such full-grown individuals the transverse section is truly helmet-shaped, as in *Arcestes gigantogaleatus*, Mojs.

A similar disappearance of the marginal ridges of adult specimens has not yet been observed in *Hungarites*. On the contrary, in several species of this genus the marginal ridges are only distinctly developed in old age, so for instance, in *Hungarites Elsæ*, v. Mojsisovics (*loc. cit.*, Pl. XXIV, fig. 6, Pl. XXXIII, fig. 3, 4, p. 224), or in *H. triformis*, v. Mojsisovics (Arktische Triasfaunen, Pl. XI, fig. 14, 15, 16, p. 87).

The most conspicuous character of *Otoceras* is the gradual elevation of the umbilical margin. This latter, together with the adjoining portion of the lateral parts, is bulged out into an ear-like prolongation. This character is acquired at very different stages of growth by individuals, even of one and the same species, but is never absent in adult specimens. It is true that a similar elevation of the lateral parts near the umbilical margin has also been observed in some species of *Ptychites*, as was shown by E. v. Mojsisovics, and I described a similar character in a Siberian *Proptychites* from the Ussuri district.[2] But neither in this form nor in any species of

[1] E. v. *Mojsisovics*, Vorläufige kurze Uebersicht über die Ammoniten-Gattungen der mediterranen und juravischen Trias, Verhandl. k. k. geol. Reichs-Anstalt, 1879, p. 140.

[2] Mémoires du. Comité géol. de la Russie, XIV, No. 3, Pl. III, fig. 2.

Ptychites is the elevated umbilical margin bulged out into a true ear-like prolongation of the same size as in *Otoceras*. As this character is present in the Himálayan and Armenian species of *Otoceras*, I consider it as being of a more than merely specific value, but of subgeneric importance. The tendency to enlarge the umbilical region in old age must be of importance in the organisation of the animal, and consequently ought to be considered in the systematic position of these forms. So long as no forms with a denticulate siphonal lobe and ear-like prolongations of the umbilical margin have been discovered, I consider the latter character as being of equal value with the double pointed siphonal lobe in the diagnosis of the subgenus.

With the elevated umbilical margin a deep, funnel-shaped umbilicus is combined, recalling a similar umbilicus in many species of *Ptychites*.

The sutural line differs from that in *Hungarites* especially in the development of the siphonal lobe. The latter is always divided by a comparatively broad rounded siphonal prominence into two very narrow lateral branches, each of which terminates in a single sharp point. This character is constant in all specimens, and I have even observed it in such as are distinguished by the strangest asymmetry in the development of the rest of their sutural elements.

The margin of the aperture has not been preserved in any of the specimens. In a few the body chamber is a little larger than half a volution. I consequently believe that the entire body chamber may have been of about the same length in this subgenus as in *Meekoceras* and in *Ophiceras*.

The geologically oldest forms of *Otoceras* make their appearance in the permian beds of Julfa in Armenia, where they were discovered by Abich[1]. Three among Abich's species belong to this subgenus. These are the following :—

Otoceras tropitum, Abich (Pl. II, fig. 3, 3*a*, Pl. XI, fig. 21, p. 13).
Otoceras trochoides, Abich (Pl. I, fig. 6, 6a, Pl. XI, fig. 3, 3a, p. 17).
Otoceras pessoides, Abich (Pl. I, fig. 5, 5a, p. 15).

The latter form is somewhat doubtful, because the sutural line is not known, but its morphological similarity with *O. trochoides*, especially its high median keel and the elevation of the umbilical region, makes its relationship to *Otoceras* very probable. A more doubtful species is *Otoceras (?) intermedium*, Abich (Pl. II, fig. 4, 4a, Pl. XI, fig. 22, p. 13). The fragmentary preservation of the siphonal part does not allow of an examination of the siphonal lobe, and the elevation of the umbilical region is not very distinct.

Among these forms *Otoceras trochoides* is distinguished by the most simple sutural line, in which the second lateral saddle is not distinctly separated from the short auxiliary series. But even in *O. tropitum*, in which the development of the sutural line is considerably further advanced, the auxiliary series cannot be resolved into its single elements. In all the Himálayan species, on the contrary, the

[1] H. *Abich*, Geologische Forschungen in den Kaukasischen Ländern, I, Eine Bergkalkfauna aus der Araxesenge bei Djoulfa in Armenien, Wien, 1878.

auxiliary lobes and saddles are distinctly individualised. This difference in the relative state of development of the sutures, in the Indian and Armenian representatives of *Otoceras*, has been noticed already by E. v. Mojsisovics in his preliminary report on the Cephalopod fauna of the Himálayan trias.

Although Griesbach included all his specimens of *Otoceras* under one collective name, *O. Woodwardi*, it seemed to him (p. 106) that "several varieties, if not species" were represented amongst them. This suggestion is certainly correct, but the distinction of the different species, or rather, the selection from among the numerous forms, which are all alike and all again different from each other, of those which ought to be considered as proper species, is no easy matter. For in no genus of triassic ammonites known to me, not even in the group of *Dinarites spiniplicati*, are the variations so great as in this.

The relative proportions of height and thickness and the size of the umbilicus are so variable, even in specimens which agree in all other characters, that they cannot serve for specific distinctions. As in several species of *Ptychites*, thick and compressed varieties may be distinguished, but for specific distinctions other characters must be used. Such are, in the first place, the shape of the umbilicus and the sutural line.

A most remarkable feature in the sutural line of the Himálayan *Otoceras* is the development of rudimentary lobes at the inner margin of the second lateral and of the first auxiliary saddle. A sort of a bipartite arrangement takes place in these saddles, which become divided above by a small rudimentary, rounded off and not denticulate lobule. This lobule, which is always considerably smaller than the true lobes, is as a rule situated below the extreme apex of the saddle and nearer to its inner margin. Thus a second smaller and shorter saddle is separated from the proper saddle by this lobule.

Amongst the species of the subgenus two groups of forms may be distinguished, those in which one or two saddles are affected by the presence of similar rudimentary lobes, and those in which this is not the case. The first group will be named after *Otoceras fissisellatum*, in which the rudimentary lobule is restricted to the top of the second lateral saddle. To this a second species *O. Draupadi* may be added, in which not only the second lateral, but also the first auxiliary saddle outside the umbilical margin, is sometimes provided with a rudimentary lobe.

The second group will be named after *Otoceras Woodwardi*, Griesbach. It is distinguished from the former by the presence of entire saddles, rudimentary lobes being absent. Among this group two sections may be recognised according to the position of the auxiliary lobes and saddles in respect to the umbilical margin. One section is represented by forms in which the principal auxiliary lobe only is outside the umbilical margin, and the first auxiliary saddle is divided by the latter. In this section two species, *O. Clivei* and *O. Parbati*, may be distinguished by the different shape of their umbilici, while a third species, *O. undatum*, Griesbach, is characterised by the presence of marked wavy folds on its lateral parts. The second section is represented by *O. Woodwardi*, Griesbach, the most frequent form

of the genus, in which at least the first auxiliary saddle is completely outside the umbilical margin and the latter cuts either through the second auxiliary lobe or through the second auxiliary saddle.

I have paid special attention to the examination of the question whether in one and the same specimen the number of auxiliary lobes outside the umbilical suture increases with its successive whorls, as it is the case with some species of *Ceratites*. In quite young individuals this may be the case indeed, but certainly not after a diameter of the shell of more than 10 mm. has been reached. I have chiselled out the inner volutions of two full-grown specimens of *Otoceras Woodwardi* and traced their sutures under the lens to a diameter of the shell of 10 mm., and in both of them I have found the auxiliary lobes exactly in the same position with respect to the umbilical margin as in the adult individual. Thus it seems to be proved that the relative number of auxiliary lobes, outside the umbilical suture, is independent of the age of the specimen and may be considered to be a specific character.

It has, however, been observed by Griesbach (*loc. cit.*, p. 107), that in some of his specimens the corresponding lobes vary on each side; I have found a number of similar instances, and in one of them the asymmetry is so conspicuous (Pl. IV, fig. 3 b) that the specimen is a perfect *Otoceras Woodwardi* on one, and a perfect *O. Draupadi* on the other, side. The presence of similar transitional forms clearly shows that the evolution of the subgenus *Otoceras* in oldest triassic times was a comparatively rapid one. Thus no constant characters could be developed, which might characterise a greater number of individuals in an equal manner. I therefore believe to be right in applying a somewhat different standard of limits of species in this subgenus than in other triassic genera of ammonites.

There may be palæontologists who will find that my description, particularly of *Otoceras Woodwardi*, introduces an interpretation of the range of a species which is different from the extent given to others, and that characters which would have led to the distinction of species in other cases have been neglected in this one. I am obliged to confess that they would be correct in saying so, but I am convinced that it is simply impossible to apply the same interpretation of species to all genera of ammonites. Two, three or more species may be distinguished among the forms, united here under the name of *Otoceras Woodwardi*, according to the differences of the shape of the umbilicus and of the details of the sutural line, but between all these species transitional forms could easily be mentioned and, what is more important, the characters, which might lead to establishing those species, would not be found constant in two single individuals. In this respect a remarkable difference exists for instance between my *Otoceras Woodwardi* and a species of *Ophiceras*. Thanks to the extensive material which I was able to examine, a number of transitional forms are known between the different species in the latter genus too, but it was easy to find in every species a typical form, comprising the majority of specimens. It would be impossible to find typical forms for the species, which might be established from the forms which constitute *Otoceras Woodwardi*. As all of them have been found in one and the same bed, I prefer to

consider them as a single species with a somewhat wider range, according to the rapid transformation of its minor characters.

Thus I arrive at the following classification of the Himálayan species of this subgenus :—

I. Group of Otoceras Woodwardi, Griesbach.

1. *Otoceras Woodwardi*, Griesbach.
2. „ *Parbati*, nov. sp.
3. „ *Clivei*, nov. sp.
4. „ *undatum*, Griesbach.

II. Group of Otoceras fissisellatum, Diener.

5. (1) *Otoceras fissisellatum*, nov. sp.
6. (2) „ *Draupadi*, nov. sp.

The subgenus *Otoceras* seems to be restricted to a very narrow geological horizon, having been collected hitherto only in the upper permian of Julfa and in the lowest triassic beds of the Himálayas. E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, p. 222) suggests that *Otoceras* might perhaps be represented in the Hallstatt beds of the Salzkammergut, but no form actually belonging to this subgenus has been described as yet from strata of upper triassic age.

Group of OTOCERAS WOODWARDI, Griesbach.

1. Otoceras Woodwardi, Griesbach, Pl. II, fig 1, Pl. III, fig. 1, Pl. IV, fig. 2, 4, 5, Pl. V, fig. 1, 3, 5, Pl. VI, fig. 16.

1880. *Otoceras Woodwardi*, Griesbach. *pro parte*, Palæontological Notes on the Lower Trias of the Himálayas, Rec. Geol. Surv. of India, XIII, 106. Pl. I, fig. 4, Pl. II, fig. 2, 3, 6, non fig. 1, 4, 5.

Dimensions.

	Pl. II, fig. 1.	Pl. III, fig. 1.	Pl. IV, fig. 2.	Pl. V, fig. 5.
Diameter of the shell . . .	152 mm.	103 mm.	71 mm.	52 mm.
„ „ umbilicus . .	18 „	16 „	11 „	6·5 „
Height of the last volution { from the umbilical suture	96 „	61 „	37 „	29 „
Height of the last volution { „ „ preceding whorl	56 „	34 „	26 „	app. 21 „
Thickness of the last volution .	75 „	65 „	app. 35 „	18 „
„ „ „ outside the ear-like umbilical ridge	57 „	48 „	28 „	18 „
Distance from the siphonal edge to the umbilical margin (in projection)	82 „	53 „	30 „	30 „

As was shown in the introduction, Griesbach has united all his specimens of *Otoceras*, with the exception of *O. undatum*, under the same specific name, *Otoceras Woodwardi*. In the text no special form is mentioned as type of the species, nor is it possible to find out whether Griesbach himself considered any among them as the prototype, for which the name consequently ought to be retained. According to the rules of palæontological terminology, the form, which is figured first in his Memoir, must therefore serve as this prototype. It is the one, figured Pl. I, fig. 4, reproduced in this Memoir Pl. IV, fig. 2.

Owing to the wide range which I give to this species, as has been explained

in the introductory remarks, most of the Himálayan *Otoceras* are included in it, and it thus turns out to be the most frequent species of the subgenus.

Its general characters have been very well demonstrated by Griesbach, and I have but little to add to his detailed description.

The proportions of height and thickness of the transverse section, the shape of the umbilicus, and the mode of involution vary very considerably, but this variability affects the single individual in the same manner as the species itself.

The transverse section is helmet-shaped and higher than broad, as a rule, at least in adolescent stages of growth before a distinct umbilical ridge has been developed. In quite young specimens the largest transverse diameter is situated above the umbilical margin and approximately corresponds to the upper boundary of the lower third of the height of the lateral parts (Pl. V, fig. 5). Only after the elevation of the umbilical margin has been gradually developed, a second larger transverse diameter begins to be noticed, corresponding to the umbilical margin. This latter rapidly increases in size and considerably surpasses the former in adult specimens. For a long time, however, the shell remains somewhat inflated at the place corresponding to its first greatest thickness, and a slight, flatly rounded depression marks the interval between the upper inflated region of the volution and the umbilical ridge (Pl. III, fig. 1b, Pl. II, fig. 1b).

The three-edged termination of the siphonal part is distinctly marked even in the juvenile stage. In some specimens the marginal ridges persist in adult individuals or faint indications of them at least are visible (Pl. III, fig. 1). In others the tripartite character of the siphonal side becomes completely lost in old age. Then this part of the shell has quite the appearance of a sharp knife (Pl. II, fig. 1, Pl. V, fig. 1), the lateral parts uniting under an angle of from 60 to 80°. The siphonal edge itself is frequently drawn out into a slightly elevated keel, especially in adult specimens.

In the juvenile stage the transverse section is exactly identical with that of *Hungarites*, no elevation of the umbilical margin being indicated. The ear-like prolongation of the umbilical margin is acquired in later stages of growth only, but its development takes place at very different stages in different individuals. In adult specimens the umbilical margin bulges out into an elongated ridge, which slopes less steeply towards the lateral parts than to the umbilicus, and terminates in a perfectly sharp edge. In young specimens the umbilical margin is very narrowly rounded.

The most variable character is the shape of the umbilicus. In some specimens—Griesbach's type specimen (Pl. IV, fig. 2), for instance—the umbilicus is quite funnel-shaped. The umbilical wall slopes quite regularly towards the umbilical suture which coincides with the spiral of involution. In this respect, however, Griesbach's type specimen itself is asymmetrical. On one side of the shell the involution takes place exactly on the umbilical margin of the preceding whorl, leaving only the umbilical wall of the inner volutions visible inside the umbilicus. On the other side, however, the spiral of involution is outside the umbilical margin

of the preceding whorl, and a narrow strip of the lateral parts of the inner volutions is consequently visible inside the umbilicus.

The variability of the shape of the umbilicus is intimately connected with the variability of the involution, which takes place either exactly at the umbilical margin of the preceding whorl or somewhat more or less outside the latter. In this respect the two sides of the shell are frequently unsymmetrical as in the above mentioned instance or in the specimen figured Pl. II, fig. 1. But even in different stages of growth the involution varies considerably. As a rule the tendency prevails to increase the amount of involution in adult specimens, as was observed by Griesbach. But instances of the reverse are equally known to me.

The different mode of involution is, however, not the only cause of the remarkable variability in the shape of the umbilicus. To the different degree of involution a varying height and steepness of the umbilical wall may be added.

In few specimens only does the umbilical wall form a regularly, more or less steeply inclined plane as in Griesbach's type-specimen (Pl. IV, fig. 2). In most of the specimens this character of the umbilical wall is restricted to the inner volutions, if it is present at all (Pl. V, fig. 3). In the last volution the umbilical wall is often vertical, or even overhangs the umbilical suture. A specimen is mentioned by Griesbach, in which the umbilicus is narrower in the last volution, closing in towards the outer side. This is also the case in the specimen Pl. II, fig. 1, but on one side only. On the side from which the measurements have been taken, reproduced in the figure as the better preserved of the two, the umbilical wall slopes steeply towards the umbilical suture and its lower portion only is perfectly vertical, these two differently inclined portions joining in a graceful curve. On the other side, however, the umbilical wall is not only vertical for a longer distance, but even slightly concave in the vicinity of the umbilical suture. This concave shape of the lowest portion of the umbilical wall is very strongly marked in the specimen Pl. III, fig. 1. Here the umbilical wall describes a falciform curve in its transverse section, and overhangs the umbilical suture so considerably that the projection of the distance between the siphonal keel and the umbilical margin exceeds the height of the volution above the umbilical suture.

The overlap of the last whorl over the preceding one is also liable to a certain variability. It amounts from one third to seven twenty-fourths of the entire height of the former.

The shell is comparatively thick, especially near the ear-like ridge of the umbilical margin, where the shell substance becomes as much as twice as thick as in the vicinity of the siphonal part. It is covered with numerous delicate, S-shaped lines of growth, which are generally arranged into bundles, originating in the umbilical margin and gradually increasing in size towards the siphonal margin. This sort of ornamentation is very similar to that exhibited by *Ophiceras Sakuntala*. Indistinct wavy folds frequently correspond to these bundles in the cast. The striæ of growth on the umbilical wall are directed backward, whereas they are turned forwards in the lower portion of the lateral parts. In the upper portion of the latter they first

describe a gentle curve with backward turned convexity and are bent forward again near the siphonal margin. With this forward bent direction they cross the marginal ridges and the siphonal keel.

In two specimens I observed a body chamber, exceeding but very little one half a volution in length. Some of the largest specimens (Pl. II, fig. 1, Pl. III, fig. 1) consist almost entirely of air chambers, and full-grown individuals of this species must have reached a considerable size. The specimen Pl. II, fig. 1, for instance, seems to have attained a diameter of scarcely less than 220 mm.

Sutures.—The vertical projection of the periphery of the penultimate whorl touches the apex of the second lateral saddle. Two lateral lobes are consequently present.

The presence of at least four saddles outside the umbilical margin is peculiar to this species. The shape of the lobes and saddles is subject to a very considerable variation. The only constant character is the bifid termination of the siphonal lobe, which is divided by a broad rounded siphonal prominence. The latter is either very low, of a semicircular shape, or reaches half as high as the siphonal saddle. The siphonal saddle is always smaller than the principal lateral one, sometimes (Pl. IV, fig. 5b) it even recalls that of *Ptychites* owing to its reduced size. It is elongated, with parallel borders and either broadly or narrowly rounded above. The principal lateral lobe is the deepest as a rule. But in some specimens almost all the lobes, except the siphonal one, are on the same level (Pl. II, fig. 1). This lobe as well as the second lateral one is strongly denticulated at its base, but the arrangement and shape of the denticulations varies in every specimen and even on each side of the same individual. It is scarcely of any use to enter into a detailed description of the different arrangement of these denticulations. The most simple type is represented in Pl. IV, fig. 5b, or Pl. VII, fig. 16, the most complicated in Pl. II, fig. 1c. The shape of the two lateral saddles varies from the symmetrical saddle with parallel walls and moderately rounded top to the obliquely sloping one, with its highest point leaning over to its internal side, or to a clumsy shape, with an irregularly depressed apex. The shape and size of the auxiliary lobes and saddles is equally variable. The second auxiliary saddle is, as a rule, much broader than the first. In the specimens, Pl. V, fig. 3, and Pl. VII, fig. 16, it is itself divided into two independent saddles.

The umbilical margin either cuts through the second auxiliary lobe or through the second auxiliary saddle. The first auxiliary saddle, however, is always completely outside the umbilical margin.

The relative level of the different sutural elements is extremely variable. As different types the figures, Pl. II, fig. 1c, Pl. V, fig. 3b, and 5b, may be cited. In the first instance the siphonal lobe is very short, but the rest of the lobes stand almost on the same level, the principal lateral lobe reaching but very little deeper. In the specimen, Pl. V, fig. 5b, which may be considered as the most frequent type, the siphonal lobe is very short, the principal lateral lobe is deepest, the second lateral lobe is shorter, and from this lobe the following ones slope down very

slightly. In the specimen Pl. V, fig. 3b, the siphonal lobe is very deep, almost as deep as the principal lateral lobe; the second lateral lobe is much higher than the siphonal, and from this one the following lobes slope very strongly towards the umbilical suture. The second auxiliary lobe is consequently at a lower level than the siphonal and principal lateral lobes.

A third—or, in specimens in which the second auxiliary saddle is divided by a true lobe, a fourth—auxiliary lobe is as a rule outside the umbilical suture, which intersects the commencement of an adjoining saddle.

The lobes of the antisiphonal side were already observed by Griesbach. The figure Pl. VII, fig. 16, is taken from Griesbach's specimen. The saddle, which has been described above as partly outside the umbilical suture in some specimens, is followed by a deep lobe and by a second higher saddle with undulating top the highest point of which is leaning over towards the antisiphonal lobe. The latter itself is rather short, very narrow, and bipartite. The two antisiphonal saddles are broad and slightly indented above, the top consequently terminating in a double, flat culmination.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground 3, Coll. Griesbach; 28, Coll. Diener; Kiunglung encamping ground, S.W. of Niti Pass 1, Coll. Griesbach.

2. OTOCERAS PARBATI, nov. sp. Pl. IV, fig. 1.

Dimensions.

Diameter of the shell		72 mm.
„ „ „ umbilicus		16 „
Height of the last volution	from the umbilical suture	35 „
	„ „ preceding whorl	23 „
Thickness of the last volution		33 „

Although this species is based on a single specimen only, I believe its separation to be justifiable, as it is in excellent preservation and distinguished from all the rest by its much smaller involution. The last whorl overlaps the penultimate one to the extent of two thirds of the height of the latter only. A considerable portion of the inner volutions is consequently exposed within the comparatively wide umbilicus. The ear-like prolongation of the umbilical margin is distinctly marked in the anterior portion of the last volution. The umbilical edge is very narrowly rounded off. The high and vertical umbilical wall is very slightly arched. The tripartite arrangement of the siphonal part is more strongly developed in the beginning than near the anterior termination of the last volution.

Very low, falciform folds, of a somewhat indistinct character, may be seen in the posterior portion of the last volution.

The specimen consists almost entirely of air chambers, but the commencement of the body chamber coincides exactly with the anterior termination of the last whorl.

Sutures.—They differ from those in *Otoceras Woodwardi* by the presence of only three saddles outside the umbilical margin.

The vertical projection of the periphery of the penultimate whorl touches the outer margin of the second lateral saddle of the last volution. The principal lateral lobe shows a distinctly tripartite arrangement of the denticulations at its base. The first auxiliary saddle is divided into two unequal portions by the umbilical margin. The second auxiliary lobe is very broad, strongly serrated, and followed by a second auxiliary saddle, situated, as it seems, completely outside the umbilical suture.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Kiunglung encamping ground, S.W. of Niti Pass 1, Coll. Griesbach.

3. Otoceras Clivei, nov. sp. Pl. III, fig. 2, 4, Pl. V, fig. 4, Pl. VII, fig. 17.

1880. *Otoceras Woodwardi*, Griesbach, *pro parte*, Palæontological Notes on the Lower Trias of the Himálayas, Records, Geol. Surv. of India, XIII, Pl. II, fig. 4.

Dimensions.

	Pl. III, fig. 4.	Pl. V, fig. 4.
Diameter of the shell	86 mm.	69 mm.
" " " umbilicus	10 "	7·5 "
Height of the last volution from the umbilical suture	47 "	39 "
Height of the last volution from the preceding whorl	33 "	27 "
Thickness of the last volution	39 "	25 "

Most of the specimens of this species recall in the mode of their involution and in the shape of their umbilici, the forms of *Otoceras Woodwardi* figured on Pl. IV, fig. 2 and 4. Although in some specimens the umbilical suture leaves the normal spiral in the last volution, the umbilicus always remains funnel-shaped and the contrast with *O. Parbati* is a very decided one.

The specimen Pl. V, fig. 4, is a very compressed form, whereas the specimen Pl. III, fig. 4, is characterised by its elongated shape and comparatively slowly increasing whorls. The specimen Pl. III, fig. 2, represents a normal type with moderately inflated volutions.

The umbilical wall slopes under an oblique but regular angle in most of my specimens, and is but very slightly arched.

The tripartite arrangement of the siphonal part becomes almost entirely lost in the body chamber of the largest specimen, Pl. III, fig. 4.

Sutures.—The sutural line is very similar to that of *Otoceras Parbati*. There are three saddles only, situated outside the umbilical margin, which cuts through the first auxiliary saddle. The contrast in the shape of the first and second auxiliary lobe, which is so remarkable in *O. Parbati*, is but rarely observable in specimens of this species. In most of the latter on the contrary these two lobes are of nearly equal size and shape. There is always a third auxiliary lobe and the commencement of a third auxiliary saddle outside the umbilical suture. In some specimens the small size of the second auxiliary saddle is remarkable (Pl. V, fig. 4).

The individual variability in the shape of the different sutural elements is scarcely less conspicuous than in *Otoceras Woodwardi*. The specimen Pl. VII,

fig. 17, is distinguished by the presence of a very large indentation at the bottom of the principal lateral lobe and by low and broad, clumsily shaped saddles with comparatively narrow lobes between them. The central incision in the siphonal prominence shown in this figure is, however, a pure imagination of the draughtsman.

A strange asymmetry is seen in the corresponding lobes on each side of the specimen, Pl. III, fig. 2. One side the specimen shows the typical arrangement of the sutures, as in other individuals of this species; on the other side, from which the drawing fig. 2 c. has been taken, their arrangement is as in *Otoceras Woodwardi*. The very small and narrow auxiliary saddle is completely outside the umbilical margin, which cuts through the second auxiliary lobe. To this difference in the position of the first auxiliary saddle, the extraordinary development of the first auxiliary lobe may be added. This is not only broader than all the other lobes, but is also provided with a very strong indentation in its centre, which almost assumes the shape of a rudimentary saddle which is sharply pointed and bordered by concave marginal walls.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground 3, Coll. Griesbach; 4, Coll. Diener; Hills above Kuling, Spiti 1, Coll. Griesbach.

4. OTOCERAS UNDATUM, Griesbach, Pl. IV, fig. 6.

1880. *Otoceras Woodwardi* var. *undatum*, Griesbach, Palæontological Notes on the Lower Trias of the Himálayas, Records, Geol. Surv. of India, XIII, Pl. I, fig. 5, p. 107.

Dimensions.

Diameter of the shell	42	mm.
" " " umbilicus	6	"
Height of the last volution { from the umbilical suture	23	"
Height of the last volution { " " preceding whorl	16	"
Thickness of the last volution	17	"

This species agrees in its general shape, mode of involution and sutures with *Otoceras Clivei*, but differs in having very marked, wavy folds, which in their direction follow the growth lines of the shell. They are strongest near the middle portion of the lateral parts, and gradually die out towards the siphonal part. They are considerably broader and much more distinctly defined than the narrow bundles, which are developed by the local accumulation of growth lines in *Otoceras Woodwardi*. The presence of such distinct wavy folds induced Griesbach to separate this form as a proper variety from his *Otoceras Woodwardi*. The comparatively strong development of the folds is the more remarkable, as the two specimens serving for description are still in the adolescent stage and consist of air chambers only. Owing to their small size, the prolongation of the umbilical margin is but faintly indicated.

Sutures.—Identical in their arrangement with those in *O. Clivei*. The umbilical margin divides the first auxiliary saddle into two equal portions. Three auxiliary lobes and two auxiliary saddles are outside the umbilical suture, which cuts through the third auxiliary saddle.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground 2, Coll. Griesbach.

GROUP OF OTOCERAS FISSISELLATUM.

5. (1.) OTOCRAS FISSISELLATUM, nov. sp. Pl. III, fig. 3, Pl. V, fig. 2.

1880. *Otoceras Woodwardi*, Griesbach *pro parte*, Palæontological Notes on the Lower Trias of the Himálayas, Records, Geol. Surv. of India, XIII, Pl. II, fig. 5, and fig. 1, 1a. 1b.

Dimensions.

	Pl. III, fig. 3.
Diameter of the shell	51 mm.
" " " umbilicus	8 "
Height of the last volution { from the umbilical suture	27 "
" " " { " " preceding whorl	18 "
Thickness of the last volution	29 "
" " " outside the ear-like umbilical ridge.	20 "

Otoceras fissisellatum may be roughly defined as an *O. Clivei* with a rudimentary lobe at the apex or the inner margin of its second lateral saddle. It is a rather rare species and it is probably only in consequence of its rarity that no great individual variability has been observed.

In its general characters it is completely identical with the typical *O. Clivei* or an involute form of *O. Woodwardi* with a sloping umbilical wall and a funnel-shaped umbilicus. The specimen figured Pl. III, fig. 3,—the same as is figured in Griesbach's Pl. II, fig. 1,—is remarkable owing to its strongly developed ear-like prolongation of the umbilical margin, which in proportion to the small size of the individual, consisting of air chambers only, bulges out very considerably.

Sutures.—The arrangement of the sutures is the same as in *O. Clivei*. There are not more than three saddles on the lateral parts outside the umbilical margin, which cuts through the first auxiliary saddle.

The asymmetrical development of the denticulations at the base of the lateral lobes on each side in the specimen Pl. III, fig. 3, was noticed by Griesbach, who also described the presence of the rudimentary lobule in the second lateral saddle. "In some specimens," he says (p. 107), "the first auxiliary lobe reaches only half down the rounded and broad second lateral saddle, and is not serrated at the base and might be described as a rudimentary lobe." I prefer indeed to consider it as such and not as a proper auxiliary lobe, as it is very different in its size, shape and position from the true auxiliary lobe.

The auxiliary series is identical with that observed in *O. Clivei*. Three auxiliary lobes and an equal number of saddles outside the umbilical suture, by which the third auxiliary saddle is divided into two unequal portions.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground 1, Coll. Griesbach; 3, Coll. Diener.

6. (2.) OTOCERAS DRAUPADI, nov. sp., Pl. IV, fig. 3, Pl. V, fig. 6, Pl. VII, fig. 15.

Dimensions.

		Pl. IV, fig. 3.
Diameter of the shell		63 mm.
" " " umbilicus		7 "
Height of the last volution	from the umbilical suture	35 "
	" " preceding whorl	24 "
Thickness of the last volution		24 "

This species stands in a similar relation to the preceding one, as *Otoceras Woodwardi* is to *O. Clivei*. It is distinguished by the presence of four saddles outside the umbilical margin, which cuts through the second auxiliary lobe.

Among the five specimens described, three are characterised by high and compressed whorls, whereas in the two others the volutions are strongly inflated. In all the specimens the shape of the umbilicus recalls that in the specimen of *O. Woodwardi* figured Pl. III, fig. 1. The umbilical suture is surrounded by a very high and vertical umbilical wall, which is moderately convex in its transverse section and distinctly concave in its lower portion. In my largest specimen, in which the height of the last volution is from 50 to 55 mm. near the commencement of the body chamber, the marginal edges have completely disappeared and the sharp siphonal keel is joined by the lateral parts converging under an angle of about 60°.

In the specimen Pl. IV, fig. 3, the arrangement of the numerous lines of growth of the shell in narrow bundles is very distinctly marked.

Sutures.—In spite of the small number of specimens which represent this species in the Himálayan collection, the individual variability is considerable. *O. Draupadi* differs from the preceding species owing to the presence of four saddles outside the umbilical margin. The second lateral saddle is provided with a rudimentary lobe, as in *O. fissisellatum*, but the shape of the first auxiliary saddle is very variable. It is either normally developed (Pl. V, fig. 6), or very small and narrow (Pl. VII, fig. 15) or also provided with a rudimentary lobe on its apex, like the second lateral saddle (Pl. IV, fig. 3).

The latter specimen is distinguished by a very conspicuous asymmetry in the development of the second lateral and the first auxiliary saddles on each side. On one side the saddles are provided with rudimentary lobes, whereas on the other they are entire. This asymmetry, which may be observed in all the septa of this specimen, is quite different from the asymmetrical position of the lobes in some liassic ammonites, as described by F. v. Hauer[1] and Geyer,[2] which results from a deviation of the siphonal lobe from the median plane of the shell. Thus our specimen constitutes a perfect transitional form between *Otoceras Draupadi* and *O. Woodwardi*.

Locality and Geological position. Number of specimens examined.—Otoceras beds. Shalshal Cliff near Rimkin Paiar encamping ground 1, Coll. Griesbach; 4, Coll. Diener.

[1] *F. v. Hauer*, Ueber einige unsymmetrische Ammoniten aus den Hierlatz-Schichten, Sitzungsber kais. Akad. d. Wiss Wien, math. nath. Cl., XIII, 1864, p. 401

[2] *G. Geyer*, Ueber liasische cephalopoden des Hierlatz bei Hallstatt, Abhandl. k. k. geol. Reichs-Anstalt., XII, 1886, p. 240, 243.

FAUNISTIC AND GEOLOGICAL RESULTS.

It has already been pointed out in the introduction to this Memoir that the lower trias in the Himálayas may be divided according to its stratigraphical conditions into two separate horizons, the lower of which is known under the name Otoceras beds, introduced by C. L. Griesbach, whilst I propose for the upper the name subrobustus beds, from one of its most interesting fossils, *Ceratites subrobustus*, v. Mojsisovics.

The study of the faunæ of the Himálayan lower trias confirms the correctness of a separation of the two horizons, as each of them is characterised by a distinct cephalopod fauna, not a single species extending from the one into the other.

I shall first treat of the cephalopod fauna of the subrobustus beds, as it exhibits closer affinities to other triassic faunæ hitherto described, and has even a few identical species with the Olenek beds of north-eastern Siberia. It is composed of the following species :—

1. *Pleuronautilus*, sp. ind.
2. *Nautilus*, sp. ind. *ex aff. N. Palladii*, Mojs.
3. *Orthoceras*, sp. ind.
4. *Danubites nivalis*, nov. sp.
5. " *Purusha*, nov. sp.
6. " *Kapila*, nov. sp.
7. " *cf. trapezoidalis*, Waagen.
8. *Ceratites subrobustus*, Mojs.
9. " *Mandhata*, nov. sp.
10. *Hedenstrœmia Mojsisovicsi*, Diener.
11. " *sp. ind. ex aff. Mojsisovicsi.*
12. *Proptychites sp. ind. ex aff. P. obliqueplicato*, Waagen.
13. *Flemingites Salya*, nov. sp.
14. " *Rohilla*, nov. sp.
15. " *sp. ind. ex aff. Fl. trilobato*, Waagen.
16. *Aspidites superbus*, Waagen.
17. *Koninckites Yudishthira*, nov. sp.
18. *Lecanites Sisupala*, nov. sp.
19. " *sp. ind.*
20. *Meekoceras cf. fulgurato*, Waagen.

This fauna consists of 20 species, of which no less than seven are not sufficiently well known to merit a proper designation. Of the remaining 13 species, ten belong to the fauna of the subrobustus beds of Muth in Spiti, which was discovered by Griesbach and is by far the richest known from this horizon.

As regards the geological age of this fauna, as compared with other triassic cephalopod-bearing strata, we find that close relations exist between it and that of

the Siberian Olenek beds, which is contained in the collections of Middendorff, Czekanowski and Baron Toll, and was described by Graf Keyserling and Mojsisovics.

In the first place there is a specific identity of two forms, *Ceratites subrobustus*, v. Mojsisovics, and *Hedenstroemia Mojsisovicsi*, Diener, to be recorded. This identity is the more remarkable, as in this case we have to do with very characteristic species on the one hand, and on the other with deposits which are separated from each other by a distance of 700 geographical miles. In the presence of those two identical species—among a total number of 13 of which we have a satisfactory knowledge—the close relations are clearly marked, by which the faunæ of the Indian and of the Arctic-Pacific province were connected in lower triassic times. A similar affinity is not observed to exist between the fauna of the subrobustus beds and of the upper, cephalopod-bearing horizon of the Alpine Werfen beds (Campiler Schichten of von Richthofen), which are homotaxial with the Olenek beds. On the contrary the general type of the two faunæ seems to be widely different, and only in a later geological stage, during the Muschelkalk epoch, are equally close relations to the Alpine, as well as to the Arctic-Pacific trias, to be observed in the Himálayan region of the Indian triassic province.

Very close relations exist between the faunæ of the Himálayan subrobustus beds and of the Ceratite sandstone in the Salt Range, but this is a point to which I shall have to recur later on.

The fauna of the subrobustus beds is distinguished by several remarkable peculiarities. One among them is the complete absence of forms of the *Ammonea trachyostraca* with a smaller number of principal lobes than the normal. This phenomenon is repeated in the Otoceras beds. Not one single representative of the genus *Dinarites* has been discovered up to now in the Himálayan trias. This fact is the more strange, as *Dinarites* plays the most important part in the Olenek beds of Siberia, the cephalopoda of which, in general, exhibit a considerably higher stage of development than those of the Otoceras beds. As in the Arctic-Pacific region, *Tirolites* and its allies (*Dorycranites*, *Balatonites*) are absent in the lower trias of the Himálayas. Among the *Ammonea trachyostraca* only the subfamily *Dinaritinæ* of the family of the *Ceratitidæ* is represented in the subrobustus beds. Besides the subgenus *Danubites* two true species of *Ceratites* are present, one of which is identical with *C. subrobustus*, Mojsis., the well-known type fossil of the Olenek beds, whereas the other is among the simplest types of the *Ceratites circumplicati*. Among the subgenus *Danubites* a very strange group is added to those forms which have their next allies in the Otoceras beds, namely, the group of *D. nivalis*, with its remarkable sculpture, somewhat recalling *Tirolites*, and consisting of radial straight ribs, which terminate in broad elevations near the siphonal margin. Although *Danubites* seems to have its chief development in the Otoceras beds it still plays the most important part in the fauna of the subrobustus beds, as regards both the number of species (4) and of individuals.

Among the *Ammonea leiostraca* the *Pinacoceratidæ* are represented by the genus *Hedenstrœmia* (2 species), the *Ptychitidæ* by *Flemingites* (3 species), *Lecanites* (2 species), *Meekoceras* (1 species), *Aspidites* (1 species), *Proptychites* 1 (species), *Koninckites* (1 species). Most species of the *Ptychitidæ* are closely allied to Salt Range forms. One species of *Hedenstrœmia* is identical with a form described by E. v. Mojsisovics from the Olenek beds, as has already been mentioned. The family *Arcestidæ* is not represented.

All the ammonites which have been discovered in the subrobustus beds are provided with ceratitic sutures, with the single exception of *Lecanites*, whereas forms with ammonitic sutures are as yet quite unknown. It must, however, be borne in mind that the number of cephalopoda from this horizon, described in this Memoir, is certainly extremely small in comparison to the real richness of its fauna. But a more complete idea of the latter can only be obtained after an examination of new and more extensive materials from the subrobustus beds of Spiti, which in this respect promise better results than those of Johár and Painkhánda.

Our knowledge of the fauna of the Otoceras beds is much more complete, thanks to Mr. Griesbach's discoveries and to the large collections made by the expedition of 1892 at different localities. This fauna, so far as the cephalopoda are concerned, consists of the following species:—

1. *Nautilus brahmanicus*, Griesbach.
2. " *sp. ind.*
3. *Danubites himalayanus*, Griesbach.
4. " *sp. ind. ex aff. himalayano.*
5. " *lissarensis*, nov. sp.
6. " *ellipticus*, nov. sp. (?)
7. " *planidorsatus*, nov. sp.
8. " *sp. ind. ex aff. planidorsato.*
9. " *rigidus*, nov. sp.
10. " *sp. ind. ex aff. rigido.*
11. " *Sitala*, nov. sp.
12. *Medlicottia Dalailamæ*, nov. sp.
13. *Prosphingites Nala*, nov. sp.
14. " *Kama*, nov. sp.
15. *Nannites hindustanus*, nov. sp.
16. " *Herberti*, nov. sp.
17. *Proptychites Markhami*, nov. sp.
18. " *Scheibleri*, nov. sp.
19. " *sp. ind.* (group of *P. discoides*, Waag.).
20. *Vishnuites Pralambha*, nov. sp.
21. *Flemingites guyerdeti*, nov. sp.
22. *Ophiceras Sakuntala*, nov. sp.
23. " *tibeticum*, Griesbach.
24. " *medium*, Griesbach.
25. " *gibbosum*, Griesbach.
26. " *demissum*, Oppel.
27. " *ptychoides*, nov. sp.
28. " *Dharma*, nov sp.
29. " *Chamunda*, nov. sp.

30. *Ophiceras platyspira*, nov. sp.
31. " *serpentinum*, nov. sp.
32. *Hungarites sp. ind.*
33. *Otoceras Woodwardi*, Griesbach.
34. " *undatum*, Griesbach.
35. " *Clivei*, nov. sp.
36. " *Draupadi*, nov. sp.
37. " *fissisellatum*, nov. sp.
38. " *Parbati*, nov. sp.
39. *Koninckites Vidarbha*, nov. sp.
40. *Kingites Varaha*, nov. sp.
41. *Meekoceras Hodgsoni*, nov. sp.
42. " *boreale*, nov. sp.
43. " *sp. ind.*
44. " *sp. ind. aff. plicatili*, Waag.
45. *Prionolobus* (?) *sp. ind.*

This fauna is almost entirely contained in the main layer of *Otoceras Woodwardi* and in thin layers of shales and limestones following immediately above. The number of cephalopoda comprises 45 species, among which one (*Danubites ellipticus*) is doubtful, as its geological position is not known with certainty. Of the remaining 44 species, 9 are not sufficiently well preserved to allow a specific determination. With the overlying subrobustus beds this fauna has not one single species in common.

If we take the geological character exhibited by this fauna into consideration, we have at once to admit that in bears decidedly the character of a fauna of the lower Buntsandstein, as was pointed out by Griesbach and confirmed by Mojsisovics, although a much smaller material was then available. Ammonites with a ceratitic development of their sutural line predominate, and *Nannites* and *Medlicottia* must be considered as very rare exceptions from this general rule. A few specimens of *Nannites* indeed are only known from one single layer near Muth in Spiti, whilst there are only two specimens of *Medlicottia* among the rich harvest of cephalopoda, which the systematical researches of our expedition have yielded from the Otoceras beds of the Shalshal Cliff near Rimkin Paiar.

The presence of the two last mentioned genera in the Otoceras beds of the Himálayas is of special interest.

Nannities has long been known from the upper trias of the southern Alps. The absence of this genus, distinguished by persistence in a goniatitic stage of development of its sutural line and representing a geologically older type in lower triassic strata was consequently a rather strange fact and its discovery in these beds was expected. *Medlicottia* is represented in the Otoceras beds by a species belonging to the permian group of *M. Wynnei*, Waag., and is very closely allied to the latter form. Its presence introduces a palæozoic character amongst the otherwise distinctly triassic nature of the overwhelming majority of the fauna.

The *Ammonea trachyostraca* are exclusively represented by the subgenus *Danubites*, Mojs. (with 9 species), whilst true *Ceratites* seem to be absent. All

the Himálayan species belonging to this subgenus have the normal number of principal lobes; the presumptive ancestors of these forms, provided with only a single lateral lobe, must consequently be looked for in the Himálayan region in beds of a geologically older age than the lowest triassic deposits of the Otoceras stage. Among the lower triassic *Danubites* of the Indian region no affinity to forms of the Alpine triassic province is to be recorded. It is on the contrary the Arctic group of *Danubites obsoleti*, to which they can, at least partly, be compared. Although representatives of this subgenus are widely spread throughout the Otoceras beds of the Himálayas, it is only in the Lissar valley that they are important as regards numbers of individuals. In the Otoceras beds of the Shalshal Cliff, from which most of the fossils described and figured in this Memoir have been derived, they are extremely rare.

In the fauna of the Otoceras beds the *Ammonea leiostraca* largely predominate, and among them more especially the *Ptychitidæ*. Of the *Arcestidæ* one single genus only makes its appearance, *Prosphingites*, which has only been known hitherto from the Siberian Olenek beds. Two new species of this genus are described in this paper, both differing in some remarkable characters from *Prosphingites Czekanowskii*, Mojs., the Siberian representative of the genus.

Of *Medlicottia*, the only representative of the *Pinacoceratidæ*, and of *Nannites* which constitutes the type of a proper subfamily of the *Ptychitidæ*, full particulars have been given. The latter genus appears with two species in the Otoceras beds of Spiti. Extremely rich both in number of species (10) and of individuals is the genus *Ophiceras*, Griesbach, which must probably be placed among the *Gymnitinæ*, Waagen, and is distinguished from the *Meekoceratinæ* by the presence of a very delicate spiral striation, most distinctly developed in the surface of the cast. Among the ten species of this genus, which according their sculpture are either allied to *Oph. tibeticum*, Griesbach, or to *Oph. demissum*, Oppel, *Oph. Sakuntala* may be considered as the type fossil of the Otoceras beds in Painkhánda. Of this species not less than 147 specimens have been collected by Griesbach and myself. But several other species, as *Oph. Chamunda*, *Oph. serpentinum*, *Oph. tibeticum*, are also very frequent. Although *Otoceras* is certainly the most conspicuous form of the beds, which take their name from it, the different species of *Ophiceras* are their most common fossils. Two other genera belong to the *Gymnitinæ* found in the Himálayan Otoceras beds. One of them is *Flemingites*, Waagen, which has its geologically oldest representative, *Fl. guyerdeti*, in these deposits. The other is the new subgenus *Vishnuites*, which is very closely allied to *Xenaspis*, Waagen, but from which it differs by its sharp siphonal edge, which recalls *Pinacoceras* or *Buddhaites*.

Among the *Proptychitinæ* the genus *Proptychites*, Waagen, is represented by three species, two of which are allied to *P. oldhamianus*, Waag., and *P. discoides*, Waag., whereas the third one holds a rather isolated position. The genus *Meekoceras* is represented by six species. Each of the following subgenera, *Kingites* and *Koninckites*, has its share in this number with one species. To these forms must be

added a rather doubtful species, which belongs probably to Waagen's genus *Prionolobus.*

Otoceras, Griesb., from which the series of beds takes it name, appears with six species. This subgenus has the high median keel in the middle of the siphonal side, which is bordered, in younger stages of growth at least, by sharp marginal edges in common with *Hungarites*, v. Mojsisovics. It differs, however, by the ear-shaped elevation of the umbilical region and by its double pointed siphonal lobe. This subgenus is remarkable owing to its restricted vertical distribution, being confined, as it seems, to the transitional beds between the palæozoic and mesozoic deposits. Besides the lowest trias of the Himálayas it is only known from the permian strata of the Araxes valley near Julfa, which must be placed rather high in the permian system.

Among the order of the *Nautilea* only *Nautilus brahmanicus*, Griesbach, is of importance. Although Griesbach considered it to be only a variety of *N. quadrangulus*, Beyrich, it belongs to a different group on account of the external position of its siphuncle.

As regards the geological age of the Otoceras beds they were determined to be triassic by Griesbach at the time of their discovery. In his larger Memoir on the Geology of the Central Himálayas (p. 71) he looks upon them as true passage deposits between permian and trias, "as a horizon, still lower than the Werfen beds of the Alps and considerably lower than what is understood now as 'Bunter.' This accords with the finds in other parts of the world; forms closely allied, if not identical with *Otoceras*, have been found by von Abich in Armenia, etc."

Waagen[1] likewise correlates the Himálayan Otoceras beds with the Otoceras beds of Julfa and considers them as forming a transitional stage between the palæozoic and mesozoic systems. He, however, thinks them to be of an upper permian age (*loc. cit.*, p. 215), but somewhat more recent than the cephalopod beds of the upper Productus limestone, because "the mesozoic types seem to predominate over the palæozoic ones" (*loc. cit.*, p. 232).

A somewhat different view is taken by Mojsisovics in his preliminary note on the cephalopod faunæ of the Himálayan trias.[2] He considers their fauna to be a decidedly triassic one, in accordance with Griesbach, but as more recent than the Otoceras beds of Julfa in Armenia, because the species of *Otoceras* in the last mentioned deposits occupy a considerably lower stage of development than the Indian ones.

From the result of the present examination of the fauna of the Himálayan Otoceras beds it is evident that this question must be answered in favour of Mojsisovics' opinion. The reasons why they cannot be correlated with the beds of Julfa are the following:

[1] *W. Waagen*, Salt Range Fossils, Palæontologia Indica, ser. xiii, IV, Productus Limestone fossils, Geological Results, pp. 215, 232.

[2] *E. v. Mojsisovics*, Vorläufige Bemerkungen über die cephalopodenfaunen der Himalaya-Trias, Sitzungsber. kais. Akad. d. Wiss. Wien. math. nat. Cl., CI., Pt. 1., 1892, p. 377.

The permian fauna of the Araxes valley near Julfa, which was discovered and described by Abich,[1] was collected by this famous Russian geologist in grey limestones interstratified with clayish marls. As is expressly remarked by Abich, the cephalopoda and brachiopoda do not occur in separate layers but have been found together in the same beds (*loc. cit.*, p. 6). Abich erroneously considered the entire fauna, contained in these beds, as of a lower carboniferous age, and it was only after a revision of Abich's descriptions by Val. von Moeller,[2] that its permian age was demonstrated.

Among the cephalopoda the following species may be mentioned, omitting those forms which are only represented by poorly preserved or fragmentary specimens:—

Nautilus		*tubercularis*, Abich.
"		*parallelus*, Abich.
"		*dorsoarmatus*, Abich.
"		*dorsoplicatus*, Abich.
"		*cornutus*, Golowinsky.
Orthoceras		*transversum*, Abich.
"		*bicinctum*, Abich.
"		*turritellum*, Abich.
"		*margaritatum*, Abich.
"		*annulatum*, Sow.
"		*cribrosum*, Geinitz.
Gastrioceras		*abichianum*, Moeller.
Otoceras		*tropitum*, Abich.
"		*trochoides*, Abich.
"	(?)	*intermedium*, Abich.
"	(?)	*pessoides*, Abich.
Hungarites		*djulfensis*, Abich.

As has already been pointed out in detail in the descriptive part of this Memoir, the Himálayan species of *Otoceras* differ from the Armenian ones especially by a more complicated sutural line with distinctly individualised auxiliary lobes. The *Otoceras* forms of Julfa moreover are associated with cephalopoda of a decidedly palæozoic type. This is especially the case with the *Nautilea*. As was stated by Waagen, four of them have their nearest allies in the middle and upper Productus limestone of the Salt Range. *Nautilus tubercularis*, Abich, is closely allied to *N. transitorius*, Waag., *N. dorsoarmatus*, Ab., to *N. Wynnei*, Waag., whilst *N. ophioneus*, Waag., *N. connectens*, Waag., and *N. convolutus*, Waag., may be considered as vicarious forms of the Armenian *N. convergens*, Ab., and *N. parallelus*, Ab. The fifth species of *Nautilus* from Julfa, *N. cornutus*, Golow., is a typical fossil of the upper Permian deposits of Russia. Among the *Orthoceratidæ*, *Orthoceras annulatum*, Sow., is a carboniferous species, *O. cribrosum*, Gein., a permian one from Marcou's stage G. c. v. of Nebraska city. Among the *Ammonitidæ* the genus *Gastrioceras* which is common in the permo-carboniferous deposits of Russia gives a rather old look to the cephalopod fauna of Julfa. It is, however, of no small importance, that

[1] *H. Abich*, Geologische Forschungen in den Kaukasischen Ländern, I. "Eine Bergkalk-fauna aus der Araxes-Enge bei Djoulfa in Armenien." Wien 1878.

[2] *V. von Möller*, Ueber die bathrologische Stellung des jüngeren palæozoischen Schichtensystems von Djulfa in Armenien, Neues Jahrb. f. Min. geol. und Pal. 1879, p. 225.

according to Abich's report (*loc. cit.*, p. 11) the species belonging to this genus have a considerable numerical predominance.

Thus the mesozoic types are rather in the minority among the cephalopoda of the Armenian Otoceras beds, and the cephalopoda as well as the brachiopoda, which are associated with them, decidedly point to a palæozoic age of the beds in which they occur.

In the Himálayan Otoceras beds the case is, however, very different. The cephalopoda of the distinctly mesozoic type as *Danubites*, *Prosphingites*, *Ophiceras*, *Flemingites*, *Vishnuites*, *Proptychites*, *Meekoceras*, are in an overwhelming majority. With them one single genus only, *Medlicottia*, occurs, which up to now has been looked upon as typically permo-carboniferous and permian, but representatives of this genus are extremely rare among the rich fauna of this stage.

I consequently agree with Griesbach and v. Mojsisovics, as regards the geological position of the Indian Otoceras beds, and I consider them as forming the base of the Buntsandstein, that is the lowest triassic beds, following immediately above the upper boundary of the permian deposits, without any distinct demarcation. Their fauna, and more especially the fauna of the main layer of *Otoceras Woodwardi* is the oldest cephalopod fauna of triassic age, which has yet been discovered. It is somewhat younger than the *Otoceras* fauna of Julfa, but older than the cephalopod horizon of the Alpine Werfen beds. In the Alps no cephalopod-bearing strata correspond to this Himálayan horizon, but only the bivalve fauna of the lower division of the Werfen beds (Seisser Schichten of v. Richthofen).

A triassic fauna of a similar character, which I indeed consider to be homotaxial to the Indian Otoceras beds, was discovered in 1887 by Margaritow in the Ussuri district of eastern Siberia. The triassic deposits of this region were surveyed in detail during the following years by the Russian mining engineer D. L. Iwanow, especially on the Island Russkij (Russian Island) and on the peninsula separating the Amur and Ussuri Bays, in the centre of which the town of Vladivostok is situated. The trias consists of calcareous or quartzitic sandstones, overlying unconformably crystalline and semicrystalline strata, with large masses of intrusive rocks. In a few places the base of the triassic deposits is formed by a conglomerate which is of a geologically younger age than the mountain limestone of the carboniferous epoch, as it contains fossiliferous fragments of this formation.

The cephalopoda collected by Margaritow and Iwanow were entrusted to me for examination, the result of which is to be published in the Mémoires du Comité géologique de la Russie at St. Petersbourg. Up to now a short preliminary note has only appeared.[1]

Among Iwanow's collections two faunistically different triassic horizons are represented by typical species of ammonites. The upper one is of Muschekalk age and contains *Monophyllites sichoticus*, a form closely allied to *M. Hara* from the

[1] Mittheilungen uber triadische cephalopodenfaunen von der Ussuri-Bucht und der Insel Russkij in der ostsibirischen Küstenprovinz, Sitzungsber. kais. Akad. d. Wiss. Wien, math. nat. Cl., CIV, Pt. I, 1895, p. 268.

triassic limestone crags of Chitichun (Tibet), *Acrochoriceras*, sp., and *Ptychites*, sp., of the group of *rugiferi*. The lower horizon has furnished the following species of cephalopoda :—

Dinarites latiplicatus, Dien.
Danubites Nicolai, Dien.
" *sp. ind.*
Ceratites minutus, Waagen.
Xenaspis orientalis, Dien.
Pseudosageceras nov. gen. *sp. ind.*
Ussuria nov. gen. *Iwanowi*, Dien.
" " " *Schamaræ*, Dien.
Proptychites hiemalis, Dien.
" *sp. aff. hiemalis*, Dien.
" *acutisellatus*, Dien.
" *otoceratoides*, Dien.
Ophiceras cf. Sakuntala, Dien.
Koninckites septentrionalis, Dien.
Kingites Varaha, Dien.
Meekoceras boreale, Dien.
" *sp. ind. aff. boreali.*
Nautilus sp. ind. ex aff. quadrangulo (Beyr.).
Orthoceras aff. Punjabiensi, Waag.
" sp. ind. *ex aff. campanili*, Mojs.

Among this fauna, in which *Proptychites hiemalis* and *Kingites Varaha* predominate in number of individuals, there is not a single form, which is either identical or at least nearly allied to a species of the lower triassic Olenek beds of north-eastern Siberia. But there are at least two, and probably three species, identical with those of the Himálayan Otoceras beds. These are the following :—

Meekoceras boreale, Dien.
Kingites Varaha, Dien.
Ophiceras cf. Sakuntala, Dien.

A close relationship seems, moreover, to exist between Nautilus *sp. ind. ex aff. N. quadrangulo*, Beyr., and *Danubites Nicolai* on the one hand and *N. brahmanicus* and *D. himalayanus*, Griesb., on the other—the only difference between the *Nautili* consisting in the external position of the siphuncle in the latter species, and one species, *Ceratites minutus*, Waagen, is identical with one of the lower triassic forms of the Salt Range. There it has been found in the so-called Ceratite marls, to which, although probably geologically younger than the main layer of *Otoceras Woodwardi* in the Himálayas, must be assigned a considerably lower position than the Siberian Olenek beds or the Himálayan subrobustus beds, which in general correspond to the Ceratite sandstones of the Salt Range in their age.

Thus the conclusion appears to be justified, that the lower triassic sandstones of the Island Russkij and of the Ussuri district are geologically older than the Siberian Olenek beds and are approximately homotaxial with the Himálayan Otoceras beds. Their presence in the littoral province of eastern Siberia is of

great interest, not only because triassic deposits of so low a position have not been discovered hitherto in the Arctic-Pacific region, but still more on account of the close relations which exist between the faunæ of these two zoogeographical regions; relations which are most distinctly defined by the presence of identical species in spite of the great distance, more than 3,000 geographical miles, which separates the two localities from which they have been collected.

I may be allowed to offer a few remarks as to the value of the cephalopoda for the determination of the geological age of deposits in distant regions, because the conclusions, at which I have arrived, are drawn exclusively from the examination of cephalopoda, whereas the rich fauna of bivalves contained in the same beds has not yet been studied in detail. I am, however, of opinion that the result, to which a close examination of the cephalopoda leads, cannot be altered by a comparison of the fossils of the lower classes of animals. I do not accept the statistical method adopted by S. von Wöhrmann, Salomon and other geologists, who have been dealing lately with triassic fauna, whereby an equal value is attributed to all the different elements contained in a certain fauna. With Mojsisovics, Neumayr and Waagen, I believe that the cephalopoda are of a far greater importance for an exact determination of a geological horizon than all the rest of the lower classes of invertebrata. For the different stages of the jurassic formation nobody doubts the overwhelming importance of the cephalopoda, and there is no reason why the same principle should not hold good in the trias also.

An instance quoted by M. Neumayr[1] is very instructive in this respect. In 1878 a fauna was sent to the Geological Survey in Vienna which came from the Karpathian limestone crag of Babieszowka near Neumarkt in Galicia. This jurassic fauna, which was formerly quite unknown in the Karpathian "Klippen," consisted almost entirely of brachiopods, gastropods and bivalves of a decidedly liassic character. Indeed nobody doubted at that time that one had to do in this case with a typical Hierlatz fauna, exactly like that from the well-known liassic locality in the Salzkammergut. But among these fossils a few small Kellaway ammonites were mixed up, and their presence induced Uhlig[2] to place the whole fauna into the Kellaway stage, in spite of the Hierlatz character of the overwhelming majority of its elements, which were different from anything hitherto known in deposits of Kellaway age. His view was fully justified by later discoveries of a rich fauna of Kellaway ammonites in the same crag.[3]

A number of similar instances might easily be quoted. It may be specially mentioned that Mojsisovics correlated the Olenek beds with the uppermost horizon of the lower trias, and the limestones of Mengilacch with *Meekoceras* (*Beyrichites*) *affine* with the Muschelkalk, by reason of an examination of their cephalopod faunæ alone, and that the correctness of his conclusions has been fully proved by the

[1] M. Neumayr, Die geographische Verbreitung der juraformation, Denkschriften kais. Akad. d. Wiss. in Wien, L, 1885, p. 92.

[2] *V. Uhlig*, Jahrbuch k. k. geol. Reichs-Anstalt, 1878, p. 671.

[3] *V. Uhlig*, Ueber die Fauna des rothen Kelloway-Kalkes der pieninischen Klippe Babieszowka bei Neumarkt in Westgalizien, *ibid.*, 1881, p. 381.

stratigraphical conditions of the Himálayan subrobustus beds and by the presence of *Beyrichites affinis* in the Muschelkalk of the Shalshal Cliff. I am therefore of opinion that the knowledge of the cephalopoda of a certain horizon is of much greater importance for its stratigraphical correlation with other deposits than that of the other faunistic elements, and I think I am justified in considering the presence of identical species of ammonites in the faunæ of the Proptychites beds of the Ussuri district and of the Himálayan Otoceras beds as being a sufficient evidence for the correlation of the strata in which they have been collected.

There still remains the attempt to correlate the horizons known up to now in the Himálayan trias with the homotaxial beds of the Salt Range; E. v. Mojsisovics having pointed out the possibility of correlating the fauna of Muth with the ceratite beds.[1]

Through the courtesy of Mr. C. L. Griesbach and Professor W. Waagen I have been enabled to make use of the proof-sheets of Waagen's monograph on the triassic Cephalopoda of the Salt Range and to compare his type specimens with mine when studying the Himálayan material, and I am therefore able to point out more exactly the connecting links which bind together the faunæ and determine the stratigraphical divisions in the two areas.

As has already been stated by Wynne and Waagen[2] the triassic strata of the Salt Range may be most conveniently divided into three series of beds, the "Ceratite beds," the "Bivalve Limestones," and the "Dolomite series." At the base of the Ceratite beds there follow, immediately above the Chidru beds of the upper Productus limestone, sandstones and slates without fossils. They are overlaid conformably by the lower Ceratite limestone, the Ceratite marls and the Ceratite sandstone. In the latter three subdivisions, Professor Waagen recognised the lower Ceratite sandstones, the Stachella beds, and the top beds with *Flemingites flemingianus*, de Kon. The bivalve limestones are divided by Waagen into two series, the upper Ceratite limestone and the bivalve beds proper. The dolomite group is overlaid unconformably by the plant-bearing "Variegated series" of probably rhætic age.

The only triassic strata of the Himálayas, which at first sight appear to be capable of correlation with a corresponding one of the Salt Range, are the subrobustus beds. The following species from the subrobustus beds are either intimately connected or probably identical:—

Himálayas.	Salt Range.
Danubites cf. trapezoidalis, Waag.	*D. trapezoidalis*, Waag.
Proptychites sp. ind. ex aff. obliqueplicato, Waag.	*P. obliqueplicatus*, Waag.
Flemingites Rohilla, Dien.	*Fl. glaber*, Waag.
" *Salya*, Dien.	" *compressus*, Waag.
" *sp. ind. ex aff. trilobato* (Waag.).	" *trilobatus*, Waag.

[1] *E. v. Mojsisovics*, Vorläufige Bemerkungen uber die cephalopodenfaunen der Himalaya-Trias, Sitzgsber. kais Akad. d. Wiss. Wien, math. nat. Cl., CI, 1892, p. 376; Rec. Geol. Surv. Ind., XXV, 1892, p. 182.

[2] Fossils from the Ceratite Formation, Pal. Indica, ser. xiii, II, 1, and Jahrb k. k. geol. Reichs. Anstal, XLII, p. 377.

Himálayas.	Salt Range.
Koninckites Yudishthira, Dien.	*K. lyellianus*, de Kon. „ *gigas*, Waag.
Meekoceras cf. *fulgurato*, Waag.	*Meekoceras fulguratum*, Waag.
Aspidites superbus var.	*Aspidites superbus*, Waag.

With the exception of *Danubites trapezoidalis* and *Meekoceras fulguratum*, all the above Salt Range species belong to the Ceratite sandstones and more especially to the two higher subdivisions of this series, *viz.*, the Stachella beds and the *Flemingites flemingianus* beds. Taking into consideration the comparative insufficiency of the known fauna of the subrobustus beds, the close relationship between its fauna and that of the Ceratite sandstones is the more conspicuous. A correlation of these two series of beds seems quite natural consequently.

On the other hand the relationship of the faunæ of the lowest horizons of the Ceratite formation and of the Otoceras beds is certainly far less close, owing to the relative scarcity of closely allied forms in the very rich collection from the latter series. I fully agree therefore with Professor Waagen's opinion that we may correlate the main layer of the Himálayan Otoceras beds with the unfossiliferous sandstones and shales which follow immediately above the upper Productus limestone and which constitute the very base of the lower Ceratite limestone.

As far as closely allied forms are represented in the Otoceras beds and in the Ceratite formation of the Salt Range, they are restricted to the lower Ceratite limestone and to the Ceratite marls. But there is only one single form, *Danubites Lissarensis*, which may perhaps be identical with a Salt Range species *Prionolobus* (*Danubites* mihi) *buchianus*, Waagen. Among other species of the lower Ceratite limestone, *Proptychites discoides*, Waag., is closely related to a specifically indeterminable *Proptychites* from Kiunglung, and *Danubites* (*Gyronites*) *plicosus* to *D. rigidus*. The leading fossils of the two horizons exhibit also a distant similarity. In the Otoceras beds it is *Ophiceras Sakuntala*, in the lower Ceratite limestone *Gyronites frequens*, the shells of which almost entirely compose lumachella-like layers of these beds. In consequence of the external similarity of the two species, slabs of these layers from the Himálayas and from the Salt Range resemble each other closely except for the different colouring of the rock. The two species are, however, easily distinguished by the biangular siphonal part in *G. frequens*, whereas it is rounded in *Ophiceras Sakuntala*.

The faunæ of the Otoceras beds and of the lower Ceratite limestone consist in both cases almost entirely of cephalopoda. At least the overwhelming majority of their fossil contents belong to this class. As a whole the lower Ceratite limestone and probably also the Ceratite marls will have to be considered as homotaxial with the Otoceras beds, *i.e.*, with the entire sequence of beds between the Productus shales and the lowest strata of the subrobustus beds. Nevertheless the fauna of the main layer of the Otoceras beds should not, in my opinion, be directly correlated with any Salt Range fauna. The number of closely allied forms is but

very small and those which might be considered as such are rare, or not even yet completely known. The characteristic elements of the Himálayan Otoceras fauna are certainly absent in the Salt Range, and this fact is the more remarkable seeing the similarity of the facies in which the main layer of *Otoceras Woodwardi* and the lower Ceratite limestone are developed.

It consequently seems to me the most natural to correlate, in accordance with Waagen, the main layer of the Otoceras beds with the unfossiliferous shales and sandstones at the base of the lower Ceratite limestone and to consider the latter itself as well as the Ceratite marls[1] to be equivalents of the mass of shales and limestones following above the main layer of the Otoceras beds, from which with the exception of a few specimens of *Ophiceras tibeticum* no fossil has yet been made known with any certainty.

So we arrive at the conclusion that the Ceratite sandstone of the Salt Range exactly corresponds to the Subrobustus beds in age, that the rich Otoceras beds of the Himálayas correspond to unfossiliferous beds in the Salt Range, but that the period, during which the rich faunas of the lower Ceratite limestone and of the Ceratite marls were living in the Salt Range, is represented in the Himálayas by a sequence of beds, which are very poor in fossils.

An exact correlation of the upper Ceratite limestone with the Himálayan trias appears to be still more difficult.

Considering the doubtful fragments, described by Waagen as *Balatonites punjabiensis, Monophyllites sp. ind., Ceratites angularis*, etc., as quite insufficient for an exact determination, as conceded by Waagen himself, the most typical faunistic elements of this series are unfortunately without any analogy with such types as are known from other triassic areas. Such elements are for instance *Stephanites, Prionites* or the strange representatives of the genus *Sibirites*. This much is certain, that all those ammonites are characterised by a thoroughly ceratitic development of their sutural lines. In this respect they resemble the ammonites of the Ceratite sandstone and differ entirely from those of the main mass of the Himálayan Muschelkalk, so far as the *Ammonea leiostraca* are concerned. There remains, however, the possibility of a correlation with the lower Muschelkalk brachiopod-bearing beds of the main region of the Himálayas, from which one single ammonite only, *Sibirites Prahlada*, has been obtained.

As regards the complete difference of the faunas of the upper Ceratite limestone and of the Himálayan upper Muschelkalk, nobody will try to correlate them directly, but the question has still to be decided, whether the upper Ceratite limestone of the Salt Range ought not to be united with the Buntsandstein of Europe, that is whether the topmost portion of the Himálayan Subrobustus beds ought not to be considered as lower Muschelkalk, as was suggested by Waagen.[2]

[1] With the lower trias of the Ussuri district, which is approximately homotaxial with the Himálayan Otoceras beds, the Ceratite marls have one species, *Ceratites minutus*, Waagen, in common.

[2] *W. Waagen*, Vorläufige Mittheilungen uber die Ablagerungen der Trias in der Salt Range. Jahrb. k. k. geol. Reichs-Anstalt, XLII, 1892, p. 385.

In favour of the latter view the similarity of a few species of *Ceratites* with forms peculiar to the Alpine lower Muschelkalk and the comparatively frequent occurrence of *Acrochordiceras* may be quoted, although the geologically oldest representative of the last mentioned genus first appears in the lower Ceratite sandstone. But in favour of a correlation of the upper Ceratite limestone with the European Buntsandstein several facts may be quoted, the presence of *Danubites cf. trapezoidalis* and of *Meekoceras cf. fulguratus*, Waag., in the Himálayan subrobustus beds; the presence of *Celtites multiplicatus* both in the lower triassic Stachella beds and in the upper Ceratite limestone; and the close relationship of *Dinarites dimorphus*, Waagen, with *Dinarites glacialis*, Mojs., from the Siberian Olenek beds, two species which are certainly more closely related than *Ceratites, disulcus*, Waagen, is to *C. binodosus*, Mojs., or *C. murchisonianus* is to *C. Erasoni*, Mojs.

One more argument seems to me of some importance with regard to the latter view on this question. As has been demonstrated in my Memoir on the Cephalopoda of the Muschelkalk, triassic deposits of the Hallstatt facies were discovered by the expedition of 1892, near Chitichun, in Tibetan territory outside the main region of the triassic belt of the Himálayas. The rich fauna, contained in the small crags of Lochambelkichak, has proved to be geologically older than the upper Muschelkalk of the main region, but contains a large number of elements which have as yet never been met with in deposits of lower triassic age. It results that this fauna is most probably of lower Muschelkalk age; but in this fauna the ammonites with phylloid or monophyllic sutures are in the majority as compared with those with ceratitic sutures, whereas in the upper Ceratite limestone ceratitic forms alone are present.

It is true that even from this fact no decisive argument can be drawn against the possibility of a correlation of the upper Ceratite limestone with the lower Muschelkalk of the Himálayas. One may after all suppose that during the Muschelkalk period the Salt Range area held the same position, with respect to the Himálayas, as the German triassic basin held with regard to the Alps. This supposition is even corroborated by the fact that the bivalve beds and the dolomite series of the Salt Range are without any analogy in the Muschelkalk, or in the upper trias of the Himálayas.

As to the geological position of the two latter series of strata there is still no clue. As regards the bivalve beds the discovery of such a clue may perhaps be expected from the examination of the *Nautilea* and *Lamellibranchiata;* from these beds two species of *Lecanites* only (*L. laqueus*, *L. planorbis*) and a frgament of *Dinarites* (?) *sinuatus* have been hitherto described by Waagen. In the upper beds of the dolomite series *Pseudharpoceras spiniger* is the only fossil which points to an upper triassic age of this series.

To me the reason why the relationship of the lower triassic faunas of the Salt Range and of the Himálayas cannot be established more clearly seems to be a purely accidental one. It is chiefly founded on our fragmentary acquaintance with the

fauna of the subrobustus beds—the rich locality south-east of Muth in Spiti not having been sufficiently well searched for fossils as yet—and in the scarcity of cephalopoda, both in the lower Muschelkalk of the Himálayan main region and in the upper horizon of the Otoceras beds, situated above the main layer of *Otoceras Woodwardi*. A comparison of the lowest trias of the Salt Range, and of the upper Ceratite limestone, with their Himálayan equivalents is therefore equally difficult.

The tabular statement on the following page will show the relations of the Himálayan lower trias and Muschelkalk with deposits of other countries, homotaxially connected.

TABULAR STATEMENT SHOWING THE CORRELATION OF

<table>
<tr><td rowspan="2"></td><td colspan="2" rowspan="2">Eastern Alps.</td><td colspan="3">Himálayas.</td><td colspan="2" rowspan="2">Salt-Range.</td></tr>
<tr><td colspan="2">Main region.</td><td>Hallstatt development of Chitichun.</td></tr>
<tr><td>Upper Muschelkalk.</td><td colspan="2">Upper Muschelkalk
Horizon of Ceratites trinodosus.</td><td colspan="2">Muschelkalk with Ptychites rugifer, Ceratites thuilleri, Beyrichites khanikofi, Buddhaites rama, etc.</td><td></td><td colspan="2">Dolomite Group (?) (pro parte)
Bivalve beds.</td></tr>
<tr><td>Lower Muschelkalk.</td><td colspan="2">Lower Muschelkalk
Horizon of Ceratites binodosus.</td><td colspan="2">Brachiopod beds with Sibirites prahlada, Rhynchonella griesbachi, etc.</td><td>Red limestones of Chitichun (Lochambelkichak) with Procladiscites yasoda, Monophyllites confucii, Sturia mongolica, etc.</td><td colspan="2">Upper Ceratite Limestone (?)</td></tr>
<tr><td rowspan="2">Buntsandstein.</td><td rowspan="2">Werfen beds.</td><td>Campil beds
Cephalopod-bearing horizon with Meekoceras caprilense, Tirolites cassianus, Dinarites dalmatinus, etc.</td><td colspan="2">Subrobustus beds with Ceratites subrobustus, Flemingites rohilla, etc.</td><td rowspan="2">(?)</td><td colspan="2">Ceratite Sandstone.</td></tr>
<tr><td>Seiss beds.</td><td>Otoceras beds.</td><td>Unfossiliferous shales and limestones.

Main layer of Otoceras woodwardi.</td><td colspan="2">Ceratite Marls.
Lower Ceratite Limestone.

Unfossiliferous shales and sandstones.</td></tr>
<tr><td>Permian.</td><td colspan="2">Bellerophon beds of Southern Tirol and Venetia.</td><td colspan="2">Productus Shales with Productus cancriniformis, P. abichi, Spirifer musakhelensis, etc.</td><td>Limestone-crag of Chitichun No. I with Popanoceras trimurti, etc.</td><td>Upper Productus Limestone.</td><td>Chidru beds.

Jabi beds.</td></tr>
</table>

THE HIMÁLAYAN UPPER PERMIAN AND LOWER TRIAS.

Julfa, Armenia.	North-Eastern Siberia (Olenek River).	Eastern Siberia (Ussuri district).	Spitsbergen.	Idaho (U. S., America).
	Fauna of Mengilacch with *Beyrichites affinis*, *Hungarites triformis*, etc.		Daonella limestones.	
Beds with *Rhizocorallium* (?)		Sandstones with *Monophyllites sichoticus*, etc. (Russkij Island).	Posidonomya limestones.	
Shaly limestone beds with *Pseudomonotis* cf. *clarai* and (?) *Tirolites*.	Olenek beds with *Ceratites subrobustus*, *Dinarites glacialis*, etc.			
		Proptychites beds with *Proptychites hiemalis*, *Kingites varaha*, etc.		Meekoceras beds of Idaho with *Meekoceras gracilitatis*, *M. aplanatum*, etc.
Otoceras-beds of Julfa with *Gastrioceras abichianum*, *Otoceras tropitum*, etc.				

PLATE I.

Fig. 1a, b. NAUTILUS BRAHMANICUS, Griesbach. Otoceras beds. Kiunglung E. G., Painkhánda, Coll. Griesbach. Griesbach's type specimen.

Fig. 2a, b. NAUTILUS BRAHMANICUS, Griesbach. Otoceras beds. Kiunglung E. G., Coll. Diener.

Fig. 3. NAUTILUS BRAHMANICUS, Griesbach. Otoceras beds. Kiunglung E. G., Coll. Griesbach. Fragment showing the external position of the siphuncle.

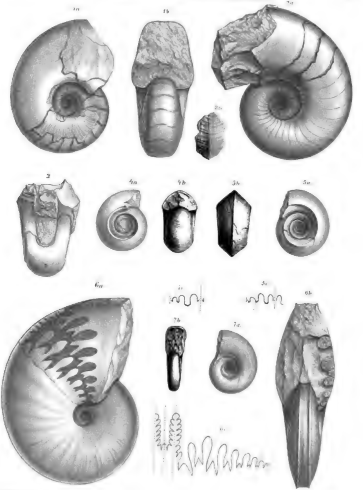
Fig. 4a, b. PROSPHINGITES NALA, Diener. Otoceras beds. Kiunglung E. G., Coll. Griesbach.

Fig. 5a, b, c. PROSPHINGITES KAMA, Diener. Otoceras beds. Kiunglung E. G., Coll. Griesbach.

Fig. 6a, b, c. MEDLICOTTIA DALAILAMÆ, Diener. Otoceras beds. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 7a, b, c. FLEMINGITES GUYERDETI, Diener. Otoceras beds. S. E. of Muth, Spiti, Coll. Griesbach.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).



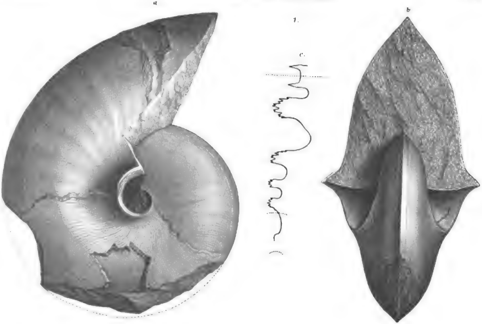
A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE II.

Fig. 1a, b, c. OTOCERAS WOODWARDI, Griesbach. Otoceras beds. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener. Largest specimen, though still entirely chambered.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE III.

Fig. 1a, b. Otoceras Woodwardi, Griesbach. Body chamber specimen, Coll. Diener.

Fig. 2a, b. c. Otoceras Clivei, Diener. Specimen with asymmetrical sutures, Coll. Griesbach.

Fig. 3a, b., c. Otoceras fissisellatum, Diener. Coll. Griesbach.

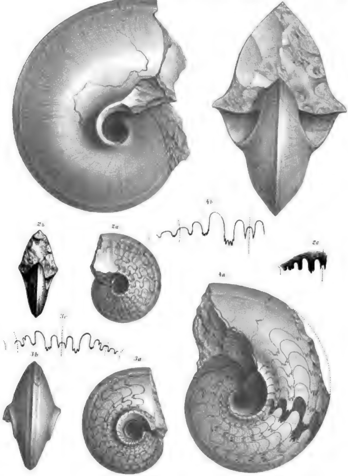
Fig. 4a, b. Otoceras Clivei, Diener. Coll. Diener.

All specimens from the Otoceras beds of the Shalshal Cliff near Rimkin Paiar E. G. (Painkhánda).

Geol. Surv. of India.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. III.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE IV.

Fig. 1a, b. OTOCERAS PARBATI, Diener. Otoceras beds. Kiunglung E. G. (Painkhánda), Coll. Griesbach.

Fig. 2. OTOCERAS WOODWARDI, Griesbach. Otoceras beds. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach. Griesbach's type specimen.

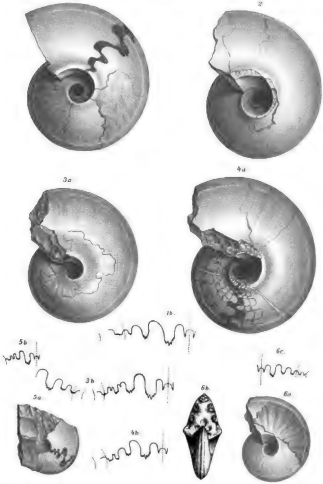
Fig. 3a, b. OTOCERAS DRAUPADI, Diener. Specimen with asymmetrical sutures, Coll. Diener.

Fig. 4a, b. } OTOCERAS WOODWARDI, Griesbach. { Coll. Griesbach.
Fig. 5a, b. } { Coll. Diener.

Fig. 6a, b, c. OTOCERAS UNDATUM, Griesbach. Coll. Griesbach. Griesbach's type specimen.

Specimens 3, 4, 5, 6 from the Otoceras beds of the Shalshal Cliff near Rimkin Paiar E. G.

Geol. Surv. of India. LOWER TRIAS, HIMALAYA (CEPHALOPODA). Pl. IV.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE V.

Fig. 1a, b. OTOCERAS WOODWARDI, Griesbach. Coll. Diener.

Fig. 2a, b. OTOCERAS FISSISELLATUM, Diener. Coll. Diener.

Fig. 3a, b.
Fig. 5a, b. } OTOCERAS WOODWARDI, Griesbach. Coll. Diener.

Fig. 4a, b. OTOCERAS CLIVEI, Diener. Coll. Griesbach.

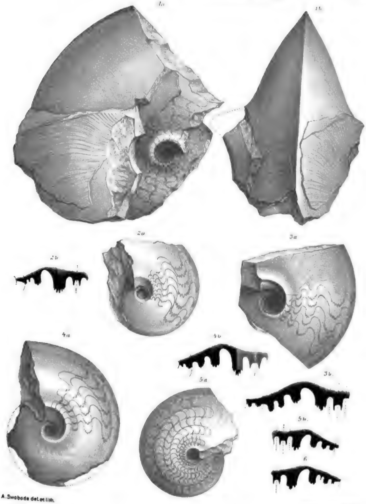
Fig. 6. OTOCERAS DRAUPADI, Diener. Coll. Diener. Sutural line.

All from the Otoceras beds of the Shalshal Cliff near Rimkin Paiar E. G.

Geol. Surv. of India.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. V.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VI.

Fig. 1a, b, c. MEEKOCERAS HODGSONI, Diener. Otoceras beds. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2a, b, c. MEEKOCERAS (KINGITES) VARAHA, Diener. Otoceras beds. Shalshal Cliff near Rimkin Paiar E. G., Coll Diener.

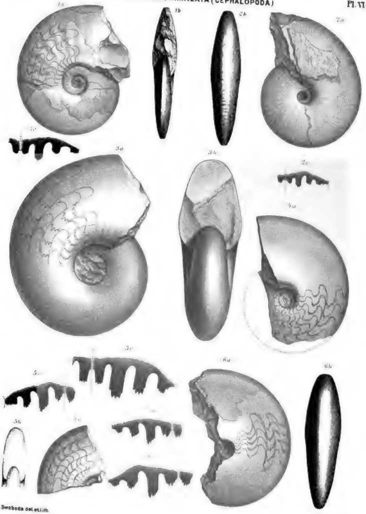
Fig. 3a, b, c. PROPTYCHITES SCHEIBLERI, Diener. Otoceras beds. Shalshal Cliff, Coll. Diener.

Fig. 4a, b. PROPTYCHITES MARKHAMI, Diener. Otoceras beds. S. of Kuling, Spiti, Coll. Griesbach.

Fig. 5a, b. PROPTYCHITES sp. ind. Otoceras beds. Kiunglung E. G., Coll. Griesbach.

Fig. 6a, b, c. PROPTYCHITES MARKHAMI, Diener. Otoceras beds. Shalshal Cliff near Rimkin Paiar E. G., Coll Diener.

LOWER TRIAS, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VII.

Fig. 1a, b, c. Meekoceras boreale, Diener. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2a, b. Nannites Herberti, Diener.
Fig. 3a, b, c. Nannites hindostanus, Diener. } S. E. of Muth, Spiti, Coll. Griesbach.

Fig. 4a, b, c, d.
Fig. 5. } Vishnuites nov. subg., Pralambha, Diener. Shalshal Cliff, Coll. Diener.

Fig. 6a, b, c. Meekoceras (Kingites) Varaha, Diener. Hills above Kuling, Spiti, Coll. Griesbach.

Fig. 7a, b. Medlicottia Dalailamæ, Diener. Fragment from the Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 8a, b. Meekoceras (Koninckites) Vidarbha, Dien. S. of Dharma No. XI, Lissar Valley, Coll. Griesbach.

Fig. 9a, b, c. Meekoceras (Koninckites) Vidarbha, Dien. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 10a, b. Meekoceras, sp. ind. S. of Kuling, Spiti, Coll. Griesbach.

Fig. 11. Nannites hindostanus, Diener. S. E. of Muth, Spiti, Coll. Griesbach. Full grown specimen with its apertural margin preserved.

Fig. 12a, b, c, d, e, f. Nannites hindostanus, Diener. Interior whorls and sutures of a specimen from the same locality. Fig. 12 d, e, f four times enlarged.

Fig. 13a, b, c. Prosphingites Nala, Diener. Kiunglung E. G. (Painkhánda), Coll. Griesbach.

Fig. 14a, b, c. Prionolobus (?) sp. ind. Kiunglung E. G., Coll. Griesbach.

Fig. 15. Otoceras Draupadi, Diener. Sutures. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach.

Fig. 16. Otoceras Woodwardi, Griesbach. Complete sutural line with antisiphonal lobe. From the same locality, Coll. Griesbach.

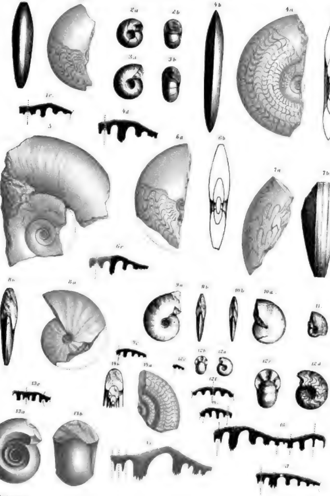
Fig. 17. Otoceras Clivei, Diener. Sutures. From the same locality, Coll. Diener.

All the specimens, figured on this plate, from the Otoceras beds.

Geol. Surv. of India.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. VII.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VIII.

OPHICERAS TIBETICUM, Griesbach.

Fig. 1a, b, c. Griesbach's type specimen. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach

Fig. 2.
Fig. 3a, b. } Kiunglung E. G., Coll. Griesbach. 3b, antisiphonal lobe.

Fig. 4. Shalshal Cliff, Coll. Griesbach.

Fig. 5a, b, c. Kiunglung E. G., Coll. Griesbach.

Fig. 6a, b.
Fig. 7. } Kiunglung E. G., Coll. Diener.

Geol. Surv. of India.

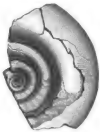
LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. VIII.

1a

1b

2



1c

3a

4

3b

6b

6a

5c

5a

5b

7

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE IX.

Fig. 1a, b, c. Ophiceras medium, Griesbach. Kiunglung E. G., Coll. Griesbach.

Fig. 2a, b, c. Ophiceras medium, Griesbach. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach.

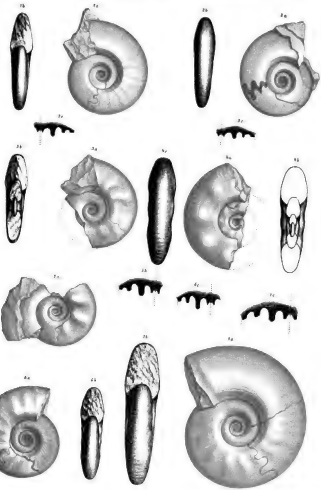
Fig. 3a, b. Ophiceras gibbosum, Griesbach. Shalshal Cliff, Coll. Griesbach.

Fig. 4a, b, d. Ophiceras gibbosum, Griesbach. Shalshal Cliff, Coll. Griesbach. Griesbach's type specimen.

Fig. 5a, b.
Fig. 6a, b, c.
Fig. 7a, b, c.
} Ophiceras gibbosum, Griesbach. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

All the specimens from the Otoceras beds.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE X.

OPHICERAS SAKUNTALA, Diener.

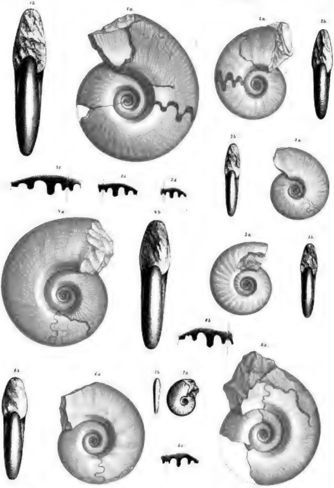
All the specimens from the Otoceras beds of the Shalshal Cliff near Rimkin Paiar E. G., with the exception of fig. 7a, b, which has been collected, by C. L. Griesbach from the Otoceras beds S. E. of Muth, Spiti.

6a, b, c (with asymmetrical siphonal lobe) and 8a, b, Coll. Griesbach the rest Coll. Diener.

Geol. Surv. of India

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. X.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XI.

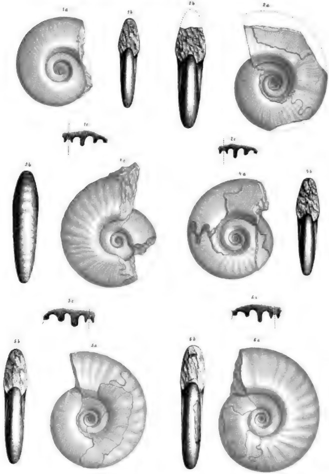
Fig. 1a, b, c. OPHICERAS SAKUNTALA, Diener. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach. Transitional form to OPHICERAS MEDIUM, Griesb.

Fig. 2a, b, c. } Fig. 4a, b. } OPHICERAS SAKUNTALA, Diener. Shalshal Cliff, Coll. Diener.

Fig. 3a, b. } Fig. 5a, b, c. } Fig. 6a, b, c. } OPHICERAS PTYCHODES, Diener. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

All the specimens from the Otoceras beds.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XII.

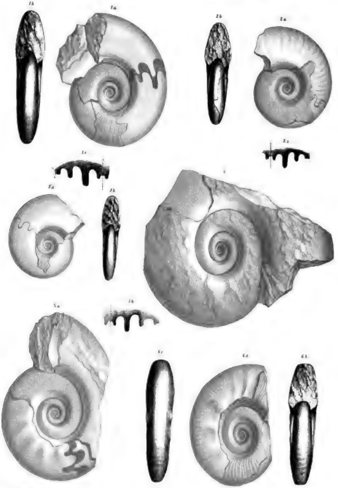
Fig. 1a, b, c.
Fig. 2a, b, c.
Fig. 3a, b. } Ophiceras Chamunda, Diener. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 4. Ophiceras Chamunda, Diener. Hills S. E. of Kuling, Spiti, Coll. Griesbach.

Fig. 5a, b.
Fig. 6a, b, c. } Ophiceras platyspira, Diener. Shalshal Cliff, Coll. Diener.

All the specimens from the Otoceras beds.

Geol. Surv. of India. **LOWER TRIAS, HIMALAYA (CEPHALOPODA).** Pl. XII.



A. Swoboda del et lith.

Th. Bannwarth print.

PLATE XIII.

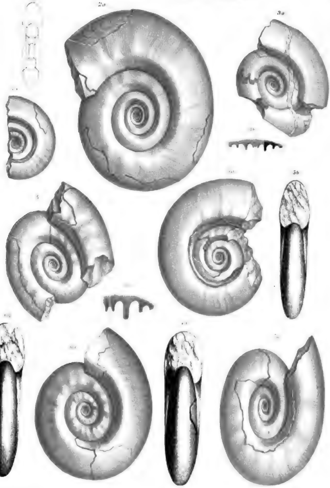
OPHIOCERAS SERPENTINUM, Diener.

Fig. 1a, b. 2a, b, 5a, b Coll. Griesbach, the rest Coll. Diener. All from the Otoceras beds of Kiunglung E. G. (Painkhánda).

Geol. Surv. of India

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. XIII



A. Swoboda del. et lith.
Th. Bannwarth print.

PLATE XIV.

Fig. 1a, b. } OPHICERAS DEMISSUM, Oppel. Kiunglung, E. G., Coll. Griesbach.
„ 2a, b.
„ 3.

Fig. 4. } OPHICERAS DEMISSUM, Oppel. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.
„ 5a, b.
„ 6.

Fig. 7a, b. OPHICERAS DEMISSUM, Oppel. Jengdi, Spiti, Coll. Schlagintweit, from the State Palæontological Museum in Munich.

Fig. 8. } DANUBITES LISSARENSIS, Diener. S. of Dharma XI, Lissar Valley, Coll. Griesbach.
„ 9.
„ 11a, b, c.

Fig. 10a, b. DANUBITES SP. IND. EX. AFF. HIMALAYANUS. S. of Dharma XI, Lissar Valley, Coll. Griesbach.

Fig. 12. } DANUBITES ELLIPTICUS, Diener. Hills above Kuling, Spiti, Coll. Griesbach.
„ 13a, b.

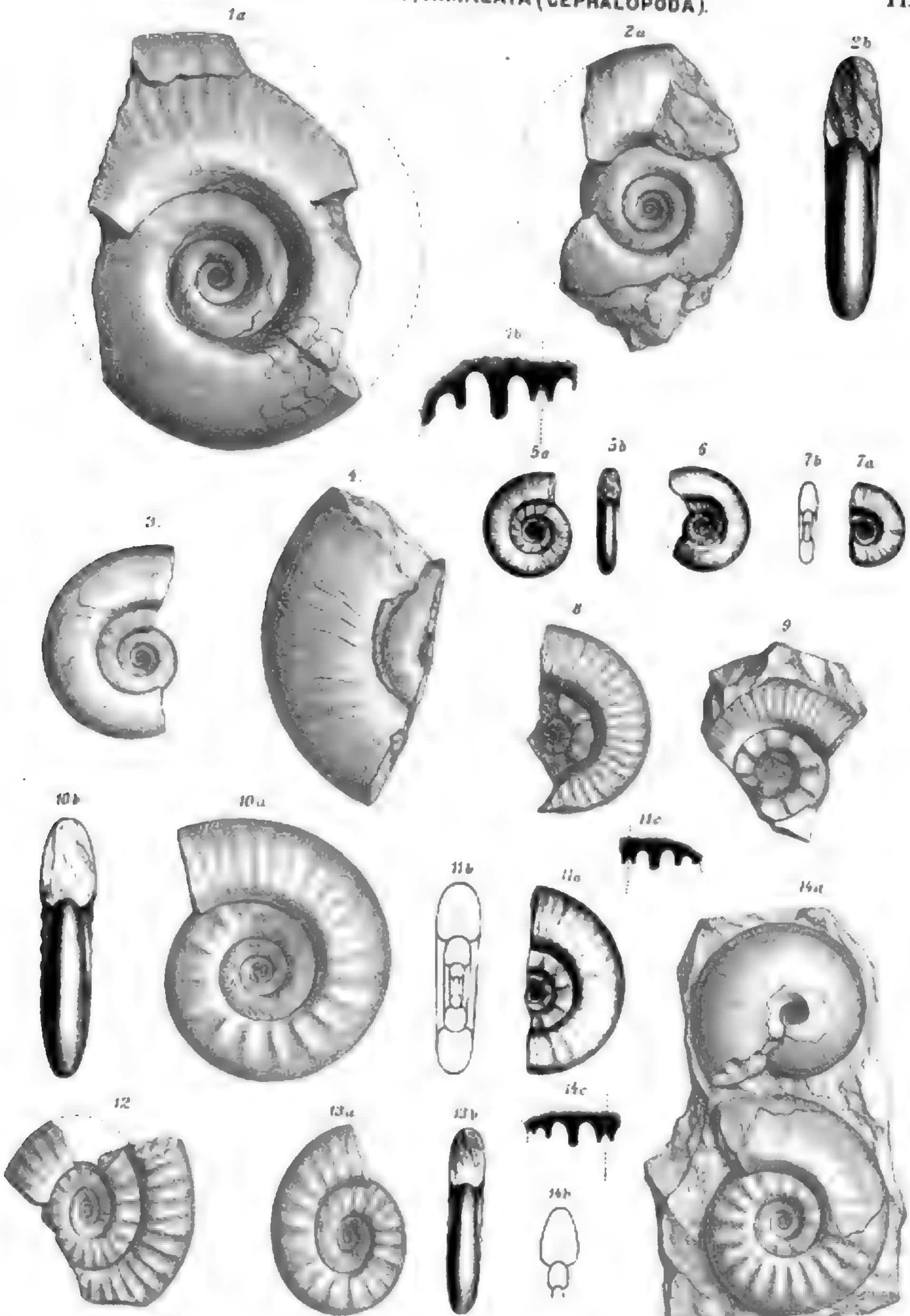
Fig. 14a, b, c. DANUBITES HIMALAYANUS, Griesbach. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach. Griesbach's type specimen.

All the specimens from the Otoceras beds, with exception perhaps of DANUBITES ELLIPTICUS, the stratigraphical position of which is uncertain.

Geol. Surv. of India.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. XIV.



A Swoboda del. et lith.

Th. Bannwarth print.

PLATE XV.

Fig. 1a, b, c. } DANUBITES PLANIDORSATUS, Diener. Otoceras beds. Hills S. of Kuling, Spiti,
„ 2a, b, c. } Coll. Griesbach.

Fig. 3a, b. DANUBITES SP. IND. AFF. PLANIDORSATO. Otoceras beds. Hills above Kuling, Spiti, Coll. Griesbach.

Fig. 4a, b. } DANUBITES RIGIDUS, Diener. Otoceras beds. S. of Dharma XI, Lissar Valley,
„ 5a, b. } Coll. Griesbach.

Fig. 6a, b, c. MEEKOCERAS SP. IND. EX. AFF. PLICATILI, Waagen. Lower trias (exact stratigraphical position unknown). Hills above Kuling, Spiti, Coll. Griesbach.

Fig. 7. DANUBITES SP. IND. AFF. PLANIDORSATO, Diener. Otoceras beds. Shalshal Cliff near Rimkin Paiar, E. G., Coll. Diener.

Fig. 8a, b. OPHICERAS DHARMA. Diener. Otoceras beds. S. of Dharma XI, Lissar Valley, Johár, Coll. Griesbach.

Fig. 9a, b. OPHICERAS DHARMA, Diener. Otoceras beds, Shalshal Cliff, Coll. Diener.

Fig. 10a, b. DANUBITES CF. TRAPEZOIDALIS, Waagen. Subrobustus beds. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 11. DANUBITES SP. IND. AFF. RIGIDO, Diener. Otoceras beds. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 12a, b, c. } DANUBITES SITALA, Diener. Otoceras beds. S. of Dharma, Lissar Valley,
„ 13. } Johár, Coll. Griesbach.

Fig. 14a, b, c. DANUBITES PURUSHA, Diener. Subrobustus beds. S. of Dharma XI, Lissar, Valley, Coll. Griesbach.

Fig. 15. DANUBITES PURUSHA, Diener. Subrobustus beds, Sutures of a full grown specimen from the hills above Kuling, Spiti, Coll. Griesbach.

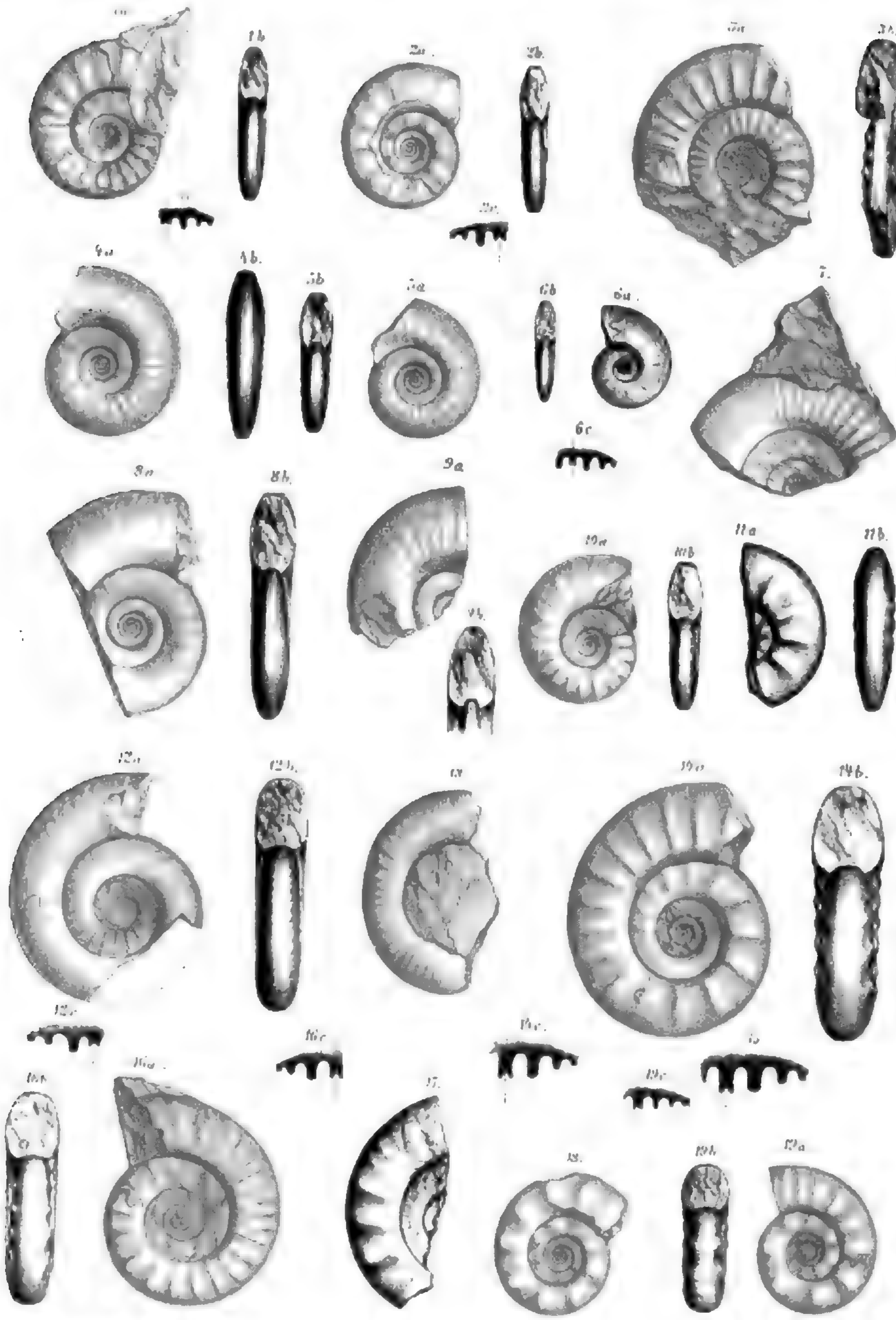
Fig. 16a, b, c. DANUBITES KAPILA, Diener. Subrobustus beds. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 17. } DANUBITES NIVALIS, Diener. Subrobustus beds. S.E., of Muth, Spiti, Coll.
„ 18. } Griesbach.
„ 19a, b, c. }

Geol. Surv. of India

LOWER TRIAS, HIMALAYA (CEPHALOPODA)

Pl. XV.



A. Swoboda del. et lith.

Th. Bannwarth print.

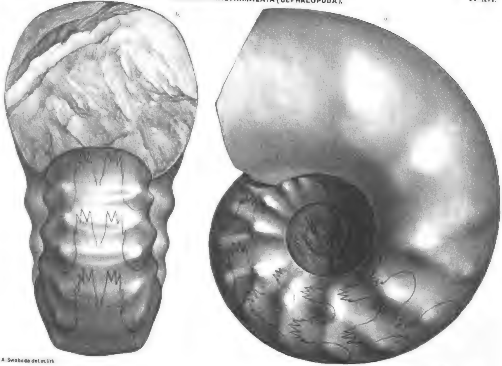
PLATE XVI.

CERATITES SUBROBUSTUS, E. v. Mojsisovics. Subrobustus beds. Shalshal Cliff, near Rimkin Paiar E. G., Painkhánda, Coll. Diener. See also Pl. XIX, fig. 2.

Geol. Surv. of India

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

Pl. XVI.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XVII.

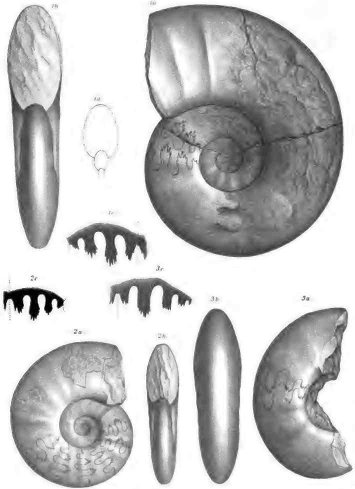
Fig. 1a, b, c, d. CERATITES MANDHATA, Diener. S. E., of Muth, Spiti, Coll. Griesbach. 1d. transverse section of the last volution near its commencement.

Fig. 2a, b, c. FLEMINGITES SP. IND. EX. AFF. TRILOBATO, Waagen. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 3a, b, c. PROPTYCHITES SP. IND. EX. AFF. OBLIQUEPLICATO, Waagen. Kiunglung E. G., Painkhànda, Coll. Diener.

All the specimens from the subrobustus beds.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).



A. Swoboda del et lith
Th. Bannwarth print.

PLATE XVIII.

Fig. 1. MEEKOCERAS CF. FULGURATO, Waagen. Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach.

Fig. 2a, b, c. FLEMINGITES ROHILLA, Diener. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 3a, b, c. FLEMINGITES CF. ROHILLA, Diener. Bambanag Cliffs, Girthi Valley, Johár, Coll. Diener. The sutures (3c) so deeply weathered that the denticulations have been completely destroyed.

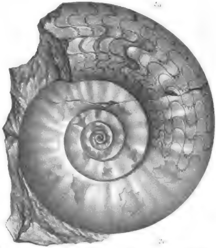
Fig. 4a, b, c. FLEMINGITES ROHILLA, Diener. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

All the specimens from the subrobustus beds.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).

1

2a



2b

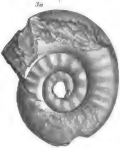
4c

3b

2c

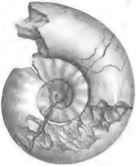
3c

3a



4b

4a



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XIX.

Fig. 1a, b, c. FLEMINGITES SALYA, Diener. Subrobustus beds. S. E. of Muth, Spiti, Coll. Griesbach.

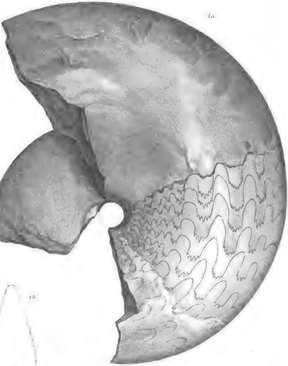
Fig. 2. CERATITES SUBROBUSTUS, E. v. Mojsisovics. Sutural line from the specimen figured on Pl. XVI.

PLATE XX.

Fig. 1a, b, c. HEDENSTROEMIA MOJSISOVICSI, Diener. Subrobustus beds. S. E. of Muth, Spiti, Coll. Griesbach.

Fig. 2a, b. NAUTILUS BRAHMANICUS, Griesbach var. HEXAGONALIS. Otoceras beds. Kiunglung E. G., Coll. Griesbach.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).


1a


1b


1c


2b


2a

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXI.

ASPIDITES SUPERBUS, Waagen var. Subrobustus beds. S. E. of Muth, Spiti, Coll. Griesbach.


Ged
A.S

PLATE XXII.

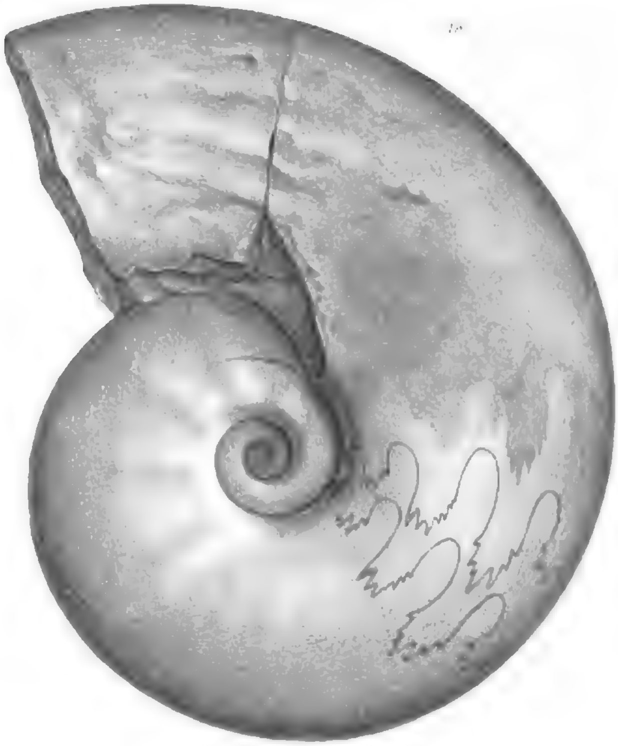
Fig. 1a, b, c. MEEKOCERAS (KONINCKITES) YUDISHTHIRA, Diener. Subrobustus beds. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 2a, b. HEDENSTROEMIA SP. IND. EX. AFF. MOJSISOVICSI, Diener. Subrobustus beds. S. E., of Muth, Spiti, Coll. Griesbach.

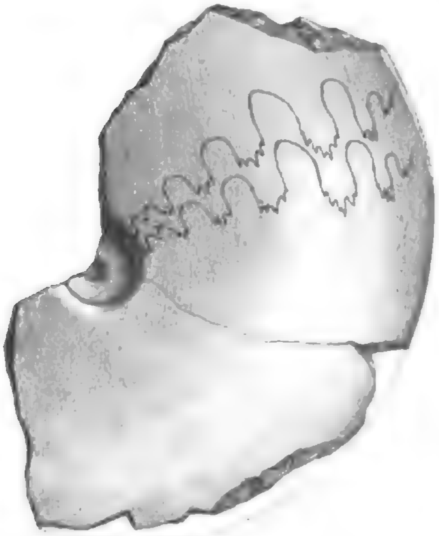
Geol. Surv. of India. Pl. XXII.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).


1b


1a

2a



1c

2b

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXIII.

Fig. 1a, b, c, FLEMINGITES ROHILLA, Diener. Subrobustus beds. S. E., of Muth, Spiti, Coll. Griesbach.

Fig. 2a, b, c. LECANITES SP. IND. Subrobustus beds. Bambanag Cliffs, Girthi Valley, Johár, Coll. Diener.

Fig. 3a, b, c. LECANITES SISUPALA, Diener. Subrobutus beds. Shalshal Cliff, near Rimkin Paiar, E. G., Coll. Griesbach.

Fig. 4a. b, ORTHOCERAS SP. IND. Subrobustus beds. Shalshal Cliff, Coll. Diener.

Fig. 5a, b, c. HUNGARITES SP. IND. Otoceras beds. Shalshal Cliff, Coll. Diener.

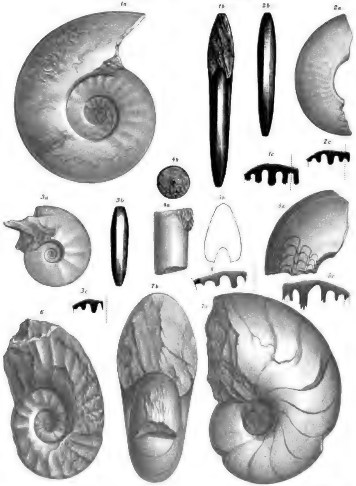
Fig. 6. PLEURONAUTILUS SP. IND. Subrobustus beds. Kiunglung E. G., Painkhánda, Coll. Diener.

Fig. 7a, b. NAUTILUS SP. IND. EX. AFF. N. PALLADII, Mojs. Subrobustus beds. Shalshal Cliff, near Rimkin Paiar E. G., Coll. Diener.

Fig. 8. MEEKOCERAS BOREALE, Diener. Sutural line of specimen from the Otoceras beds. S. of Dharma XI, Lissar Valley, Coll. Griesbach.

Geol. Surv. of India. Pl. XXIII.

LOWER TRIAS, HIMALAYA (CEPHALOPODA).



A. Swoboda del. et lith.

Th. Bannwarth print.

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PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

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Vol. II, Trias, Part 2.

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By CARL DIENER, Ph.D.,

University of Vienna.

Plates I—XXXI.

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HIMALAYAN FOSSILS.

VOL. II, TRIAS, PART 2.

THE CEPHALOPODA OF THE MUSCHELKALK.

HIMÁLAYAN FOSSILS.

VOLUME II, PART 2.

THE CEPHALOPODA OF THE MUSCHELKALK

BY

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UNIVERSITY OF VIENNA.

WITH PLATES I–XXXI.

INTRODUCTION.

General R. Strachey[1] was the first author who mentioned the occurrence of triassic deposits in the Central Himálayas. His geological reconnaissance in the neighbourhood of the Niti Pass forms one of the most important contributions to our knowledge of the stratigraphical conditions of that part of the Himálayas. Strachey mentions the presence of triassic beds in several localities of Painkhanda and the adjoining parts of Hundés, and he was the first who noticed the resemblance of a group of rocks above the palæozoic deposits to the European Muschelkalk. At the same time he lays special stress on his not having clearly recognised the importance of those formations at the time of finding them, and he declared himself unable to determine their exact geological position. Strachey's Muschelkalk is a dark-coloured limestone alternating with shales and red sandstone beds, but he adds that most of the fossils collected by him were not found *in situ*, but in loose blocks.

In 1855 Greenough alluded to the similarity of these fossils with those of the St. Cassian fauna, and Ed. Suess, who in 1862 examined Strachey's collection, believed himself justified in identifying a number of species with forms peculiar to the Trias of the Eastern Alps. Among them he enumerates: *Ammonites floridus*, *Ammonites Aon*, *Ammonites Gaytani*, *Ammonites Ausseanus*, *Ammonites diffissus*, *Halobia Lommeli*.[2] J. W. Salter, who together with H. F. Blanford published a description of the whole palæontological material collected by General Strachey, is of the same opinion with reference to the triassic fossils.[3]

[1] *R. Strachey*,—On the geology of part of the Himálaya Mountains and Tibet. Quart. Journ. Geol. Soc. VII, 1851, pp. 292—310.

[2] *E. Suess*.—Verhandlungen der K.K., Geologischen Reichs-Anstalt, Wien XII, p. 258 (Sitzung 31 Juli 1862.

[3] *J. W. Salter* and *H. F. Blanford*,—Palæontology of Niti in the Northern Himálaya. Calcutta, 1865.

The existence of triassic beds in Spiti, Ladakh, and Hundés had meanwhile been established by the examination of fossils discovered by travellers in those districts.

In 1863 H. F. Blanford described two triassic Ammonites, *Ammonites (Ptychites) Gerardi* and *Ceratites himalayanus*, collected in Spiti by Dr. Gerard, and he proved that *Ammonites Gerardi* belongs to a genus frequently met with in the Alpine Muschelkalk.[1]

In the same year A. Oppel began his important memoir on the fossils collected by the brothers von Schlagintweit in Tibet and Spiti during the years 1854 to 1857.[2] Although the geological horizons at which the different species were found had not been recorded by the collectors, Oppel correctly inferred that these fossils had not all been found in the jurassic Spiti-shales, and later on in his "Zusætze und Folgerungen," published in 1865, he assigned a great number of species to the Trias. Among the Cephalopoda described and figured by Oppel the following are of undoubtedly triassic age: *Xenodiscus*(?) *demissus*, *Ceratites Wetsoni*, *Ceratites truncus*, *Ceratites onustus*, *Ceratites Voiti*, *Ceratites Thuillieri*, *Gymnites Lamarki*, *Gymnites Jollyanus*, *Meekoceras Khanikoffi*, *Meekoceras proximum*, *Proarcestes Balfouri*, *Ptychites Everesti*, *Ptychites cognatus*, *Ptychites cochleatus*, *Ptychites rugifer*, *Ptychites impletus*, *Japonites runcinatus*.

Among these fossils he considered some of the Ceratites, especially *Ceratites Wetsoni*, to prove the existence of a distinct triassic horizon in the Himálayas,—*i.e.*, the true Alpine Muschelkalk.

In 1864 E. Beyrich described two fragments of triassic Ammonites (*Ceratites peregrinus* and *Ammonites brachyphyllus*), which the missionary Mr. Prochnow had brought from Ladakh to Europe.[3]

In 1865 C. W. Gümbel[4] examined the brachiopods and bivalves of the Schlagintweit collection. On the strength of these researches he came to the conclusion that two different triassic horizons might be distinguished in Spiti, the lower of which was represented by the sandstones of Balamsáli with *Amoplophora fassænsis*, Wissm., *Lima costata*, Münst., *Nucula-Goldfussi* v. Alb., and the upper, by dark-grey limestones with *Meekoceras Khanikoffi*, Oppel, *Lima lineata*, v. Schloth. *Waldheimia vulgaris*, v. Schloth. This upper horizon, to which belong most of the Ceratites and Ptychites described by Oppel, is considered by Gümbel to be an equivalent of the European Muschelkalk, whilst he compares the lower one to the Werfen beds of the Alpine Trias.

[1] *H. F. Blanford*,—"On Dr. Gerard's collection of fossils from the Spiti valley in the Asiatic Society's Museum." Journal Asiat. Soc. of Bengal, 1863, No. 2, pp. 121—138.

[2] *A. Oppel*,—"Über ostindische Fossilreste aus den secundæren Ablagerungen von Spiti und Gnari-Khorsum in Tibet." Palæontologische Mittheilungen aus dem Museum des Königl. bayr. Staates, I, p. 267.

[3] *E. Beyrich*,—Monatsber. Kgl. preuss. Akad. d. Wiss. Berlin, 18 Januar 1864, p. 58.

[4] *C. W. Gümbel*,—"Über das Vorkommen von unteren Triasschichten in Hochasien—(Nach den von den Gebruedern Schlagintweit gesammelten Fundstuecken beurtheilt)." Sitzungsber. Kgl. bayr. Akad. d. Wiss. 1865 [11], pp. 348—368.

To a similar conclusion came E. Beyrich[1] in his valuable memoir on the Cephalopoda of the Alpine Muschelkalk. He maintains the opinion that most of the triassic Ammonites described by Oppel bear a closer relationship to species peculiar to the Muschelkalk than to forms of the upper Trias, and he thinks that a great portion at least of the triassic deposits of the Himálayas must be looked upon as an equivalent of the Alpine Muschelkalk. He objects to Salter's identification of Himálayan species with St. Cassian and Hallstatt forms as incorrect, and at the end of his memoir sums up his views in the sentence, "that the whole Himálayan cephalopod-fauna of the Trias known at present,—provided it belonged to the same stratigraphical system,—should rather be called a fauna of the European Muschelkalk than of the upper Triassic Keuper."[2]

In strict opposition to these results of palæontological examination, Stoliczka,[3] who in 1864 had visited a number of geological sections in the North-Western Himálayas of Spiti and Rupshu, denies the existence of strata of lower triassic and Muschelkalk age. He asserts that his Lilang series, representing exclusively upper triassic deposits (Hallstätter or St. Cassian-Schichten) rests immediately on the carboniferous Kuling series, and that the Permian and the equivalents of the Alpine Buntsandstein and Muschelkalk had no representative in this part of the Himálayas.

This view, although adopted by the authors of the "Manual of the Geology of India," has not been confirmed by later examinations, neither in the field nor after close examination of the fossils. The existence of lower Trias and Muschelkalk has been proved by C. L. Griesbach in Kumaon, Gurhwal, Hundés, and Spiti. My examination of the whole palæontological material of triassic Cephalopoda in the Geological Museum in Calcutta, comprising Stoliczka's type-specimens, leads to the conclusion that probably not more than two species, *Sagenites Medleyanus*, Stol., and *Cladiscites indicus* nov. sp. (*Ammonites Gaytani* Stol.) were found in upper triassic horizons. Two others, *Isculites Hauerinus*, Stol., and *Lobites Oldhamianus*, Stol., are doubtful. All the rest are typical species of the Indian Muschelkalk. Whilst Stoliczka assumed a break of continuity between the carboniferous and upper triassic strata,[4] we know now that, on the contrary, the Himálayas contain the richest development of the lower Trias hitherto discovered.

As a distinct geological horizon in the Himálayan Trias the Muschelkalk was established by C. L. Griesbach, whose surveys form by far the most important additions to our knowledge of the geology of the Central Himálayas.[5] According to

[1] *E. Beyrich*,—"Über einige Cephalopoden aus dem Muschelkalk der Alpen und über verwandte Arten. Abhandlgn. Königl. Akademie d. Wiss. Berlin, 1866, No. 2, pp. 105—179.

[2] Most of the Cephalopoda described by Salter belong indeed to the Muschelkalk. The identification of the few genuine upper triassic forms with European species is utterly erroneous.

[3] *F. Stoliczka*,—"Geological sections across the Himálaya Mountains from Wangtu bridge on the River Setlej to Sungdo on the Indus, etc." Memoirs of the Geol. Survey of India, Vol. V, Pt. 1, Calcutta, 1865, pp. 1-154.

[4] In the results of a geological reconnaissance of Kashmir and Ladakh in 1865, published under the title "Summary of geological observations during a visit to the provinces of Rupshu, Karnag, South Ladakh, Zanskar, Suroo, and Dras of Western Tibet in 1865" (Mem. Geol. Surv. of India, V. Pt. III, 1866, pp. 337—354.) Stoliczka still maintains these views, based on his first visit to Spiti.

[5] *C. L. Griesbach*,—Records, Geol. Survey of India, XIII., 1880, p. 83-93 (Section of the Shalshal cliff), and "Geology of the Central Himálayas." Memoirs of the Geol. Survey of India, XXIII., 1891, pp. 71, 72.

this author two divisions of this stage may be distinguished. The lower division consists of a dark, sometimes earthy limestone, with a poor Brachiopod fauna of Muschelkalk type. This zone, which in the Shalshal cliff-section is only 3 feet in thickness, is closely connected with the beds above, which are grey, concretionary, generally very hard limestones, containing a typical Muschelkalk fauna.

From personal inquiry I can only confirm the full correctness of Griesbach's statement.

In Kashmir the existence of the Muschelkalk, characterised by fossil remains of the genus *Ptychites*, has been proved by R. Lydekker.[1]

In 1882 E. v. Mojsisovics published his valuable memoir on the Cephalopoda of the Mediterranean Trias.[2] In this memoir the learned author shortly discusses the triassic Ammonites described by Oppel and their relationship to Alpine forms. His conclusions fully agree with the views of Oppel and Beyrich concerning the age of the deposits from which the fossils were derived. He remarks that most of the triassic Cephalopoda described by Oppel are closely allied to species of the Alpine Muschelkalk, but that in the meantime affinities to forms of the Spitzbergen Muschelkalk seemed probable. This relationship to Spitzbergen Ammonites has been more completely worked out in the same a uthor's memoir on the faunas of the Arctic Trias.[3]

In his preliminary notes on the triassic fauna of the Himálayas, E. von Mojsisovics[4] considers the Himálayan Muschelkalk to be a clearly-defined geological horizon of the Indian province, which he looks upon as a connecting link between the triassic Mediterranean and Arctic-Pacific provinces.

A monograph on the Cephalopoda of this horizon is contained in the following pages. The materials for this work consist of the Schlagintweit collection in Munich, Griesbach's collection in the Geological Museum in Calcutta with Blanford's and Stoliczka's type-specimens, and last, but not least, in the large number of fossils collected in 1892 by the expedition to Johár, Painkhanda, and Hundés, in which C. L. Griesbach, C. S. Middlemiss, and myself took part.

My gratitude is due to Geheimrath Professor Dr. K. A. von Zittel in Munich, who kindly furnished me with Oppel's type-specimens from the Schlagintweit collection. I am also most indebted to Dr. Edmund von Mojsisovics, Vice-Director of the K. K. Geologische Reichs-Anstalt in Vienna, whose valuable advice has aided me in many ways.

[1] *R. Lydekker*,—"The Geology of the Kashmir and Chamba territories and the British district of Khágán. Memoirs, Geol. Survey of India, XXII., 1883, p. 146.

[2] *E. von Mojsisovics*,—"Die Cephalopoden der Mediterranen Triasprovinz." Abhandlgn. K. K., Geol. Reichs Anstalt i. Wien X., Bd. 1882.

[3] *E. v. Mojsisovics*, *F. Teller* und *A. Bittner*,—"Arktische Triasfaunen." Mem. de l'académie impér. de sciences de St. Pétersbourg, XXIII. Bd., 6. Lieferung, 1886.

[4] *E. v. Mojsisovics*,—"Vorläufige Bemerkungen ueber die Cephalopodenfaunen der Himalaya-Trias." Sitzgs ber Kais. Akad. d. Wiss; i. Wien; Math. Nat. Cl. Cl. 1. Abth. Mai 1892.

CHAPTER I.

THE MUSCHELKALK OF THE MAIN-REGION

DESCRIPTION OF FOSSILS.

I. AMMONEA.

A. AMMONEA TRACHYOSTRACA.

Family: *CERATITIDÆ.*

Sub-family: DINARITINÆ.

Genus: CERATITES, de Haan.

For the general character and classification of the genus *Ceratites* I refer to *E. v. Mojsisovics,* "Die Cephalopoden der Mediterranen Triasprovinz" (Abhandlungen der K. K. Geologischen Reichs-Anstalt Vienna X., 1882), p. 18; "Arktische Triasfaunen," (Memoires de l'académie impériale de sciences de St. Pétersbourg VII. ser. T. XXXIII., No. 6, 1886), p. 19; "Die Cephalopoden der Hallstætter Kalke," Vol. II. (Abhandlungen der K. K. Geologischen Reichs-Anstalt, Vol. VI, pt. 2, 1893, p. 397).

In the Muschelkalk of the Himálayas this genus is represented by 26 species. Among them 17 belong to the group of the *Circumplicati,* 4 to the group of the *Nodosi,* 3 to the group of the *Subrobusti,* 2 probably to the group of the *Geminati.*

In the Indian Muschelkalk, as in the Arctic-Pacific province of the Trias, the Ceratites of the *Circumplicati* group predominate. As to their family affinities, they seem to fall naturally into three sections. One of them contains the descendants of *Ceratites polaris,* Mojs., one of the most remarkable forms of the Arctic-Pacific province, whilst the two other sections are closely related to species of the Mediterranean Trias. One of these two sections is represented by *Certatites Wetsoni,* Oppel, and a second species of the *Wetsoni* type, both closely allied to *Ceratites Erasmi,* Mojs., of the Alpine Muschelkalk. The other subdivision comprises the groups of *Ceratites onustus,* Oppel, and *Ceratites Vyasa.* Both seem to possess a close relationship to the European *Ceratites Zezianus,* Mojs., of which species unfortunately we have a rather imperfect knowledge only. In the Alpine Muschelkalk *Ceratites Erasmi* and *Ceratites Zezianus* appear as isolated forms.

The most important forms among the Ceratites of the *Circumplicati* group are those which may rightly be considered to be descendants from *Ceratites polaris,* Mojs., from the Posidonomya Limestone of Spitzbergen. In his valuable memoir on the

triassic fauna of the Arctic-Pacific province E. v. Mojsisovics has justly laid some stress on the relationship of the Indian *Ceratites Voiti*, Oppel, to the group of *Ceratites polaris*. My examination of the rich material collected by Griesbach and myself has proved the existence of a considerable number of species representing this type in the Indian Trias. Among them *Ceratites Hidimba* of the Himálayan Muschelkalk is the nearest allied form to *Ceratites Lindstrœmi*, Mojs., and *Ceratites Oebergi*, Mojs., from Spitzbergen. In *Ceratites Hidimba* one or two ribs rise from faintly-marked umbilical tubercles on the inner whorls, whilst on the outer whorl the umbilical tubercles gradually disappear and the ribs do not separate into branches. On the shell radial growth-lines peculiar to the *Ceratites* of the *Polaris* group are well defined in *Ceratites Hidimba*. *Ceratites Dungara* differs, inasmuch as its ribs become stouter near the middle of the sides and also near the siphonal edge. Forms closely allied to *Ceratites Hidimba* are *Ceratites Arjuna* and *Ceratites Visvakarma*, with single radial ribs. A further stage of development is marked by *Ceratites Ravana* and its allies. The sculpture of their shell differs considerably from *Ceratites Hidimba*. In them, the umbilical tubercles persist in the adult stage and the ribs are, as a rule, divided on the outer whorl. To *Ceratites Ravana*, *Ceratites Airavata* stands in a relationship similar to that existing between *C. Dungara* and *C. Hidimba*. *Ceratites Voiti*, Oppel, may be considered as the most developed form of this group. In this species the ribs are not only divided on the sides of the body-chamber, but they develop into protracted, flat, lateral and marginal tubercles.

Both with reference to their sculpture and to the nature of the sutural line, the Indian representatives of the group of *Ceratites polaris*, mark a higher stage of development than the geologically older forms from the Spitzbergen Posidonomya-limestone. Even *Ceratites Hidimba*, which species shows the greatest resemblance to the Arctic forms, characterised by a small number of single ribs, shows deep, finger-like denticulations on the base of the lobes. The borders of the saddles are denticulated and their upper extremities faintly indented. Among other forms belonging to this group a small number only possess saddles, which are serrated at their upper extremities. In most of them, as in *Ceratites Voiti*, *Ceratites Ravana*, *Ceratites Airavata*, the saddles are brachyphyllic.[1]

Types of such ancient character as are represented by the group of *Ceratites decipiens*, Mojs., in the Arctic-Pacific Trias are not met with in the Indian Muschelkalk.

Within the group of the *Ceratites nodosi*, a near relationship may be observed between *Ceratites Thuillieri*, Oppel, and *Ceratites Himálayanus*, Blanf., to *Ceratites trinodosus*, Mojs., the well-known leading species of the upper portion of the Alpine Muschelkalk. *Ceratites Kamadeva* and *Ceratites Kuvera* bear sufficiently distinct characters to afford a wider separation from Mediterranean types.

The group of the *Ceratites subrobusti* is represented by three species in the Muschelkalk of the Himálayas. One of them, rather imperfectly preserved, may

1 I make use of this term in the sense given to it by E. v. Mojsisovics in "Arktische Triasfaunen" l. c., p. 63.

be compared with *Ceratites Middendorfi*, Keys. The second is allied to *Ceratites subrobustus*, Mojs., from the Olenek-beds of Siberia, but differs by more extensive denticulation of the sutures. Sharply-pointed fingers reach almost to the upper extremities of the saddles, whereas in the true *Ceratites subrobustus*, occurring also in the rock-group between the Muschelkalk and the Otoceras-beds of the Himálayas, the borders of the saddles are not serrated. A similar remark applies to the third species, *Ceratites truncus*, Oppel. Its sutures are more highly developed than in the geologically older forms of this group from the Trias of the Arctic-Pacific region.

Of the two species, which I have placed into the group of the *Ceratites Geminati*, only one can be referred to this group with full certainty. Even this form is only represented by a single, rather imperfect specimen. Nevertheless the fact alone is of sufficient interest, that forms belonging to the *Geminati* group, hitherto unknown from the Indian Trias, do occur in this formation. It forms a new connecting link between the faunas of the Arctic-Pacific province and the Himálayan region.

a. Group of the CERATITES CIRCUMPLICATI.

1. Ceratites Wetsoni, Oppel, Pl. I., fig. 6.

1865. *Ammonites Wetsoni*, Oppel, Paläontologische Mittheilungen aus dem Museum des Königl. bayr. Staates I, Taf. 86, fig. 2, p. 291.

1882. *Ceratites Wetsoni*, E. von Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlungen der K. K. Geologischen Reichs-Anstalt, in Wien, X., 1882), p. 43.

A. Oppel has founded this species on a very imperfect fragment of a chambered outer whorl. In the shape of the shell, involution and sculpture, it shows a close affinity with *Ceratites Erasmi*, as has been shown by E. v. Mojsisovics.

The whorls are much higher than broad, with slightly convex sides, which converge obliquely towards the ventral area. The greatest thickness of the whorl coincides with the lower third of its height. From the line of their greatest thickness the sides of the whorls bend down to the umbilical suture in a more convex curve. The ventral area is sharpened and forms with the sides of the whorl an obtuse edge.

Near the umbilical suture rise simple, broad folds, which gradually disappear towards the siphonal margin. They are most prominent near the lower third of the sides. The rather imperfect preservation of the specimen under description makes it impossible to give the accurate number of folds on one volution. Oppel's figure[1] is unsatisfactory in this respect and does not give a clear representation of this sculpture.

Sutures.—As has been shown by E. v. Mojsisovics, the lobe-line differs considerably from *Ceratites Erasmi*, E. v. Mojs. The upper extremities of the saddles are much broader and not serrated. The serration rises on the sides of the saddles

[1] l. c., Pl. 86, fig. 2.

only to the middle of their height. The inferior lateral lobe is much higher situated than the principal. From the first auxiliary lobe follows a broad saddle without any trace of denticulation and a second, considerably protracted auxiliary lobe.

In this respect *Ceratites nodosus*, de Haan, and *Ceratites semipartitus*, Montf., from the German Muschelkalk, show a similar arrangement of the lobe-line.

Locality, number of examined specimens.—Spiti (no particular locality known) 1, Oppel's type-specimen from the Schlagintweit collection in the Palæontological Museum in Munich.

2. Ceratites sp. ind. ex. aff. C. Wetsoni, Pl. I., fig. 3.

In my collection from the Muschelkalk of the Shalshal cliff near Rimkin Paiar Encamping Ground (Painkhanda), I have a specimen of this species, which consists of a very imperfect fragment of the outer whorl. This form seems to be closely allied to *Ceratites Wetsoni*, Oppel. The transverse section differs slightly by its greater thickness. The sides of the whorls are more convex and gradually bend towards the round siphonal area without defined borders. The lower part of the lateral area bears simple, strongly developed folds, which disappear near the ventral margin. The total number of folds on the last volution seems to be slightly greater than in *Ceratites Wetsoni*. With reference to its shape this species is still more closely allied to the Mediterranean *Ceratites Erasmi*, especially when considering its flatly rounded siphonal area, although the latter is less sharply defined from the lateral parts of the whorl than in *Ceratites Erasmi*.

The sutures, so far as preserved, are entirely identical with those of *Ceratites Wetsoni*. In this form also, the principal lateral lobe is characterised by its remarkably deep position. The upper extremities of the saddles are broad and not serrated. As the umbilical margin is wanting in our fragment, the lobe-line can only be examined as far as to the first auxiliary saddle.

3. Ceratites Voiti, Oppel, Pl. II., fig. 1, 2.

1863. *Ammonites Voiti*, Oppel: Palaeontologische Mittheilungen I. p. 276, Taf. 77, fig. 1.
1865. *Ammonites Thuillieri*, Stoliczka: ex parte Memoirs, Geological Survey of India, V., Pt. I., p. 57.
1866. *Ammonites Voiti*, Beyrich: "Über einige Cephalopoden aus dem Muschelkalk der Alpen und über verwandte Arten. Abhandlgn. Kön. Akademie der Wissensch. in Berlin, 1866, p. 115.
1882. *Ceratites Voiti*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, p. 27.
1886. *Ceratites Voiti*, E. v. Mojsisovics: "Arktische Triasfaunen:" Mém. de l'académie impér. des sciences de St. Pétersbourg, sér. VII., T. XXXIII., No. 6, 1886, p. 21.

Dimensions.	Fig. 1.	Fig. 2.
Diameter of the shell	100 mm.	83 mm.
Height of the last whorl	45 „	37 „
Thickness of the „	28 „	21 „
Diameter of the umbilicus	23 „	18 „

Ceratites Voiti is characterised by slowly increasing, very involute, compressed whorls. It is rather unfortunate that in none of my specimens the inner volutions

are satisfactorily preserved. Nevertheless the existence of a deep, scale-like umbilicus is probable, as may be concluded from the steep umbilical wall, visible in the outer whorl of Oppel's type-specimen (fig. 2). It is only well defined in the innermost extremity of this whorl. Later on, the sharp umbilical margin disappears and the lateral parts of the whorl bend with gradually increasing convexity towards the umbilical suture. Quite close to the latter, their inclination becomes perpendicular.

The ventral area is narrow, not carinate and sharply rounded. In the specimen figured in fig. 1, it becomes broadly rounded near the end of the outer whorl.

All the specimens examined are completely chambered.

The sides are slightly curved and covered with numerous broad ribs, rising near the umbilical suture. The lower portion of the ribs, as far as the umbilical margin, is directed backwards. In the middle portion of the lateral parts the direction of the ribs is perfectly radial. The ribs develop into faint tubercles in the umbilical margin and into strong elongated swellings or "bumps" near the middle of the sides. In the specimen fig. 1, these "bumps" take the shape of genuine tubercles in the last portion of the outer whorl. In the upper portion of the lateral parts the ribs become less prominent. They get broader and flatter and are strongly turned towards the aperture. A considerable number of them almost reach the middle of the siphonal side. In the specimen before mentioned, the two last ribs seem to extend into marginal tubercles. The ribs are partly simple, partly divided by the lateral swellings near the middle of their height. Besides the principal ribs, intermediate ones occur, which do not reach the umbilical margin. The proportion of simple and bifurcated ribs differs widely in different specimens. In Oppel's type-specimen, for instance, the bifurcation of ribs is the rule, whilst in the specimen figured in fig. 1, the greater number of ribs remain undivided.

Sutures.—The sutures are brachyphyllic. The saddles are denticulate, even in their upper portion. The siphonal lobe is broad and short. Three auxiliary lobes and two auxiliary saddles stand between the umbilical margin and the umbilical suture. E. v. Mojsisovics asserts, on the strength of his examination of the lobe-line in Oppel's type-specimen, the existence of a "remarkable tripartite auxiliary saddle outside the umbilical margin." In Oppel's type-specimen the last whorl, at a height of 34 mm., shows indeed only a series of single indentations near the first auxiliary lobe. But in the specimen fig. 1 the deep intersections of this are clearly visible at a height of the whorl of 40 mm. As these intersections are as deep as the first auxiliary lobe, we are, I think, no longer able to speak of one tripartite auxiliary saddle, but must admit the existence of *two* different auxiliary saddles with *three* intervening auxiliary lobes.

Locality, number of specimens examined.—Kunzum Pass (Spiti), 1, Coll. Schlagintweit, Oppel's type-specimen; Kuling (Spiti), 1, Coll. Geological Museum, Calcutta; Rimkin Paiar, 1, Coll. Griesbach.

E. v. Mojsisovics remarks the affinity of *Ceratites Voiti* to *Ceratites Petersi*, Mojs., from the red marble of the Schreyer Alpe (Salzkammergut). Both species

[1] L. c. Pl. XI., fig. 10, Pl. XI., fig. 14, p. 27.

offer indeed a good many analogies in spite of differences in the details of involution and sculpture and in the arrangement of the sutures. *Ceratites Voiti* possesses a wider umbilicus and narrower whorls in consequence of its lesser involution. In *Ceratites Petersi*, the ribs are most prominent in the lower portion of the lateral parts. The upper portion of the saddles is not denticulated.

4. CERATITES RAVANA, nov. sp., Pl. II., fig. 5, var. Pl. II., fig. 3.

Dimensions.

Diameter of the shell	86 mm.
Height of the last whorl	37 „
Thickness of the „ „	24 „
Diameter of the umbilicus	23 „

This species is most closely allied to *Ceratites Voiti*, Oppel. *Ceratites Voiti*, with which it agrees in general shape, is a little more involute, has higher whorls and a narrower transverse section. The siphonal area in *Ceratites Ravana* is less sharply rounded. Even in the last whorl, of which almost two-thirds belong to the body-chamber, the umbilical wall is perpendicular, occasionally even slightly overhanging and separated from the lateral parts by a well-marked umbilical edge, as in *Ceratites Petersi*, E. v. Mojs. (Die Cephalopoden der Mediterranen Triasprovinz· Pl. XL., fig. 14, p. 27).

Essential differences are presented by the shape of the sculpture. In *Ceratites Ravana*, tolerably flat, broad ribs rise near the umbilical margin, with tuberculate elevations. The ribs run almost straight, or with a very slight forward curve across the lower portion of the lateral area. Below the middle of the sides, they form a small prominence and become falciform. Near the siphonal margin they are strongly bent forward, in the meantime becoming broader. Near the end of the outer whorl they reach across the siphonal margin to the middle of the ventral area, where they meet at an angle of 70°, swelling out gradually. A few ribs only are single. Most of them are already bifurcate when rising near the umbilical margin. Between the principal ones, secondary ribs are intercalated in the upper portion of the lateral parts. In some of the principal ribs, a second bifurcation may be noticed.

Sutures.—There is a great resemblance with the lobe-line of *Ceratites Voiti*. The sutures are brachyphyllic, the indentation affecting even the upper extremities of the saddles. The principal lateral saddle is higher than the siphonal saddle, as in *Ceratites Voiti*. The first auxiliary lobe terminates in three sharp points and descends nearly as low as the inferior lateral lobe. One bipartite auxiliary saddle follows. The second auxiliary lobe is divided by the umbilical suture.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar E. g., 3, Coll. Diener; 1, Coll. Griesbach; Bambanag cliffs (Girthi valley), 1, Coll. Diener.

Ceratites Ravana var.—I have met with a form which differs from the last described species in possessing a more discoidal outline, higher outer whorl and more rounded ventral area, but I have considered it best to look upon this form as only a

variety of *C. Ravana*. The dimensions of a specimen from Rimkin Paiar (Pl. II, fig. 3), belonging to this variety, are as follows:—

Diameter of the shell	49 mm.
Height of the last whorl	24 „
Thickness of the „ „	13 „
Diameter of the umbilicus	11 „

The whorls overlap each other to such an extent that nearly two-thirds of the height of the last whorl are filled up by the preceding one. The umbilical margin is well marked. The umbilical walls are perpendicular but lower than in the genuine *Ceratites Ravana*, which is characterised by a deeper umbilicus.

Sculpture and sutures entirely agree with those of *Ceratites Ravana*.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar, 1, Coll. Diener; Lissar Valley, south of Dharma Nr. XI., 1, Coll. Griesbach.

5. Ceratites, nov. sp. ind. ex aff., C. Ravana. Pl. II., fig. 4.

Another species is allied to *Ceratites Ravana*, which is represented in my collection only by unsatisfactory fragments derived from the topmost strata of the Muschelkalk on the southern slope of the Utadura (Johár).

The more complete fragment comprises a little more than the half of the outer whorl and belongs almost entirely to the body-chamber. The shell is flat, discoidal with a very high and narrow cross-section. Its involution is greater and its whorls increase more rapidly than in *Ceratites Ravana*. The siphonal area is rounded. The well-marked umbilical margin is surrounded by a perpendicular wall.

The shape of the transverse section is very characteristic. As far as to the lower third of the lateral parts the sides are entirely flat, but from there, bend down in a slight curve towards each other. In the section, therefore, a very obtuse edge marks this place.

Near the extremity of the outer whorl the proportion of the height to the width of the cross-section is as 27 : 14. As my specimen does not permit exact measurements of the other dimensions, I must refer to the figure.

As in *Ceratites Ravana*, the sculpture consists of falciform ribs, the extremities of which are strongly bent forward near the siphonal margin. Single ribs have not been observed; there are only bifurcate and intermediate ribs. The bifurcation takes place either near the umbilical margin or near the lower third of the lateral parts, where it is combined with a slight swelling of the ribs. No similar swelling is visible near the umbilical margin. Towards the siphonal margin the ribs enlarge considerably, but without flattening.

Sutures.—The sutures differ but slightly from those of *Ceratites Ravana* in shape and arrangement. The saddles are equally brachyphyllic and rather high, especially the siphonal saddle. The principal lateral lobe shows unusually deep fingers along its base. The first auxiliary lobe is bipartite. The only auxiliary saddle is a simple undivided arch.

6. Ceratites, nov. sp. ind. ex aff., C. Ravana. Pl. II., fig. 6.

To another species, closely allied to *Ceratites Ravana*, belong two fragments of outer whorls. One of them, bearing the label "Spiti," is in the Schlagintweit collection and marked by Oppel as *Ceratites Voiti*. The other fragment was collected by myself in the Muschelkalk of the Shalshal cliff near Rimkin Paiar Encamping Ground (Painkbánda).

Oppel's specimen shows a portion of the body-chamber and a few traces of the preceding inner whorl. This is one of the two specimens mentioned by E. v. Mojsisovics in his notice on *Ceratites Voiti* (Cephalopoden der Mediterranen Triasprovinz, p. 27). The transverse section is narrower and higher than in *Ceratites Ravana* (height 39. mm., thickness 22. mm.). The lateral parts of the preserved whorl are covered with more numerous ribs, but the shape and the direction of the ribs are almost identical in both species. Besides the strong umbilical tubercles, faint tubercle-shaped elevations rise in the lower portion of the lateral area. In the fragment from Rimkin Paiar, these lateral tubercles are still more clearly marked. It is in these lateral tubercles that the ribs usually bifurcate.

7. Ceratites Airavata, nov. sp. Pl. IV., fig. 3.

Dimensions.

Diameter of the shell	55 mm.
Height of the last whorl	27 „
Thickness of the „ „	17 „
Diameter of the umbilicus	9 „

To *Ceratites Ravana*, *Ceratites Airavata* stands in much the same relationship as *Ceratites Dungara* (Pl. III., fig. 2) to *Ceratites Hidimba* (Pl. III., fig. 1). There are many affinities between the two species in general shape as well as in involution and sculpture. *Ceratites Airavata* has a narrower umbilicus, a lower aperture, and its flatly rounded ventral area encloses an obtuse angle with the flattened lateral parts. The last whorl overlaps two thirds of the preceding one. The umbilicus is very narrow and deep, so that only thin strips of the inner whorls are visible. The umbilical margin is sharply marked and separated from the umbilical suture by a perpendicular wall.

In the present specimen one third of the last whorl belongs to the body-chamber.

The sculpture of the inner whorls consists of flat radial ribs, whilst in the outer whorl it approaches somewhat the sculpture of *Ceratites Ravana*. As a rule two, sometimes even three, ribs rise from strong, tubercle-shaped elevations near the umbilical margin, and run in a falciform direction across the lateral parts towards the siphonal margin. In the middle of the sides some of the ribs become bifurcate. A point of difference between *Ceratites Ravana* and the present species is marked by the existence in *Ceratites Airavata*, of well-defined tubercles near the siphonal

margin, which correspond with the termination of the ribs, whilst in *Ceratites Ravana* the ribs gradually flatten towards the siphonal area.

Sutures.—The differences in the sutures of *Ceratites Airavata*, *Ceratites Voiti*, and *Ceratites Ravana* are only insignificant. In all these forms the saddles are brachyphyllic and serrated up to their topmost extremities. In the present species the first auxiliary lobe is more strongly indented than in *Ceratites Voiti*. Between this lobe and the umbilical suture appear to follow two auxiliary lobes and as many saddles. But the preservation of my specimen does not permit a very precise description.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

8. Ceratites, nov. sp. ind. Pl. IV., fig. 4.

Dimensions.

Diameter of the shell	51 mm.
Height of the last whorl	26 „
Thickness of the „ „	13 „
Diameter of the umbilicus	?

The only specimen of this species is in my collection, but is unfortunately in a rather unsatisfactory state of preservation. The lower portion of the last whorl especially is but partially preserved. Neither the shape of the inclusion of the inner whorls nor the sutures have been completely studied.

This remarkable species has a very high last whorl, and a rounded, highly curved ventral area. The inner whorls show a broad, elliptical transverse section, and increase but slowly. Their lateral parts are covered with broad, strong, straight ribs, either radial or directed obliquely forward. The height of the cross-section of the outer whorl rapidly increases and the ribs gradually disappear,—so much so, that their place is taken by flat folds which consist of numerous thin radial striae, which do not reach the siphonal margin.

Sutures.—Of these only the siphonal lobe, the siphonal saddle and the principal lateral lobe are preserved. The lobes are broad and deeply indented along their base. The upper extremity of the siphonal saddle is not serrated.

I have not considered it advisable to assign a specific name to this remarkable form, as in consequence of the imperfect state of preservation its diagnosis is rather incomplete.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

9. Ceratites Hidimba, nov. sp., Pl. III., fig. 1.

Dimensions.

Diameter of the shell	121 mm.
Height of the last whorl	46 „
Thickness of the „ „	34 „
Diameter of the umbilicus	40 „

Shell with flat, slowly increasing whorls, overlapping one-third of the preceding whorl. A slight *egression* is perceptible in the external whorl.[1] The flattened, but very slightly curved lateral parts pass into the strongly rounded siphonal area without any marked border. Nor is the umbilical margin sharply marked in the outer whorl but bends gradually down in a flat curve towards the umbilical suture. Only the inner whorls are separated from each other by a steep wall, which surrounds the umbilical margin. Transverse section high, rectangular, with rounded edges.

The sculpture consists of numerous ribs, directed slightly forward towards the mouth and considerably narrower than the intervals between them. They terminate near the siphonal margin, by forming faint prominences, from which they turn sharply forward flattening out rapidly. In the middle portion of the lateral area, the ribs show a slight wavy curve, interrupting their straight direction. Here a second maximum of height is attained by the ribs, but these elevations are not sufficiently defined to give them the character of tubercles. The transverse section of the ribs is of a triangular, sharp and roof-like shape, the intervals describe regular arches in their section. The ribs disappear near the rounded umbilical margin.

It is only the outer whorl, which is characterised by this kind of sculpture. In the inner whorls the ribs rapidly and considerably decrease in strength, whilst they seem to reach their greatest intensity near the middle portion of the body-chamber. Consequently the lateral parts of the inner whorls are only covered with flat, wavy folds, which show the same direction and arrangement, as the ribs on the outer whorl. Most of these folds are dichotomous. They bifurcate near the umbilical margin, whilst the rest remain undivided. Near the umbilical margin of the inner whorls traces of tubercles are visible, from which these folds rise.

Number of ribs in the last whorl : 30.

In the specimen figured Pl. III. fig. 1, one-half of the last whorl belongs to the body-chamber.

In the inner whorls a portion of the shell is preserved. It shows the well-marked transverse growth-lines so characteristic of the Ceratites of the group of *Ceratites polaris*, Moja. (Arktische Triasfaunen l. c. p. 30, 34).

Sutures.—There is a great resemblance between *Ceratites Hidimba* and *Ceratites Voiti*, Oppel, regarding the arrangement and general shape of the sutures. Two auxiliary lobes, and one quadripartite auxiliary saddle are situated outside the umbilical suture. The great height of the siphonal tubercle, which nearly equals the siphonal saddle, is very remarkable. The walls of the saddles are intersected by deep, finger-like indentations up to the middle of their height. The upper extremities of the saddles are but faintly serrated. In *Ceratites Voiti* both the brachyphyllic indentation of the saddles and the partition of the auxiliary saddle are further deve-

[1] This term has been introduced by E. von Mojsisovics ("Die Cephalopoden der Hallstätterkalke," p. 11) to express the change in the spiral line, which appears in the body-chamber whorl of adult specimens of some triassic genera (*Lobites*, *Didymites*, *Homerites*, *Jovites*, etc.). It shows itself either as a contraction near the margin of the aperture only, or, as for instance in Tropites and Jovites, over the larger part of the last whorl. In the latter case a shortening of the height, or at least a lessening of the ratio of increase of height, appears along with the egression. This *egression* or contraction of the whorl ought to be distinguished from the *evolution*, which term means the disjunction of the whorls, as in *Crioceras* or *Choristoceras*.

loped. In *Ceratites Hidimba* the auxiliary saddle shows a tripartite arrangement of serration. Of these three indentations, the central intersects it, it is true, somewhat deeper than the two others, but still without leading to an individualisation of the two parts, which would stamp each of them as forming an independent auxiliary saddle. In *Ceratites Voiti*, however, this incision is as deep as the first auxiliary lobe. There can be no doubt, therefore, about the existence of two independent auxiliary saddles in the last-mentioned species. In the septa immediately preceding the beginning of the body-chamber, the first leaf of a second auxiliary saddle appears outside the umbilical suture.

Locality, number of specimens examined.—East slope of Tsang Tsok La, Hop Gadh, Hundés, 1, Coll. Griesbach; Tibet (?), precise locality not known, 1, Coll. Schlagintweit (from the Palæontological Museum in Munich). East slope of the Marchauk Pass, N.-W. of Barahoti Encamping Ground (Painkhanda), 1, Coll. Griesbach.

10. Ceratites, sp. ind. ex. aff. C. Hidimba. Pl. III., fig. 3.

A species, probably very closely allied to *Ceratites Hidimba*, is represented by two rather fragmentary specimens. One of them consists of a fragment of an entirely chambered whorl, and belongs to the collection of the Geological Museum in Calcutta, and comes, I believe, from Spiti (the locality is not marked on the label). The other, an outer whorl, with a portion of the body-chamber, I collected myself near Kiunglung Encamping Ground, on the southern slopes of the Niti-Pass.

The principal difference between *Ceratites Hidimba* and this form consists in its considerably greater number of ribs. In the specimen from Kiunglung, having a diameter of 160mm. the ribs occur to the number of 18 on half of one circuit. In the (better preserved) fragment from the Geological Survey's collection the ribs swell into slight, protracted elevations near the middle portion of the lateral parts. Intermediate ribs sometimes occur.

Sutures.—This species has many affinities with *Ceratites Hidimba*, both in the structure of the lobe-line and in the lobes and saddles themselves. The saddles only differ by being somewhat broader. Their upper extremities are serrated. The bipartite character of the auxiliary saddle is more developed than in *Ceratites Hidimba*. The incision of this saddle is sufficiently deep to cause the individualisation of two independent auxiliary saddles.

11. Ceratites Dungara, nov. sp., Pl. II., fig. 2.

Dimensions.

Diameter of the shell	88 mm.
Height of the last whorl	35 „
Thickness of the „ „	27 „
Diameter of the umbilicus	26 „

The following characters separate this species from *Ceratites Hidimba*, which it

closely resembles in general appearance, involution and sculpture. The transverse section is more rounded, almost elliptical, the siphonal area is narrow and highly rounded, the lateral parts are more convex, and covered with ribs which bear well-marked lateral tubercles and stronger prominences near the siphonal margin. In the last whorl these prominences take the shape of true marginal tubercles. Between the lateral and marginal tubercles the ribs run in a more strongly bent curve than in *Ceratites Hidimba*.

The occurrence of intermediate ribs is not limited to the inner whorls.

The specimens in my collection are entirely chambered.

Sutures.—Arrangement and shape of the sutures connect this species closely with *Ceratites Hidimba*. The bipartition of the auxiliary saddle is not sufficiently deep, to consider its two parts as independent saddles. As in *Ceratites Hidimba*, in the last whorl of the specimen figured Pl. II. fig. 2, a second auxiliary saddle appears outside the umbilical suture, and is divided by the latter.

Locality, number of specimens examined.—Lilang, Spiti, 1; Kuling, Spiti, 1; both from the Geological Survey's collection in Calcutta.

12. Ceratites Visvakarma, nov. sp., Pl. IV., fig. 2.

Dimensions.

Diameter of the shell	106 mm.
Height of the last whorl	41 „
Thickness of the „ „	26 „
Diameter of the umbilicus	39 „

The present species is distinguished by very slowly increasing whorls, overlapping each other not quite to a third part of their height. The shell is rather compressed, the last whorl high and rounded. In the beginning of the last and entirely chambered whorl the ventral area is still strongly curved. Only towards the extremity of the outer whorl it becomes more gently rounded. No marked border separates the siphonal area from the lateral parts. They gradually pass into each other, the convexity of the flanks increasing as they approach the ventral part. The umbilical margin is equally rounded in the outer whorl. The rather fragmentary preservation of the inner whorls in the only specimen known to me does not permit a more exact description of the umbilical region.

The sculpture consists of simple radial ribs, which occur to the number of 28 on the outer whorl. These ribs are but faintly marked in the beginning of the outer whorl and become more prominent only in the adult stage. They are slightly rounded on their edges and bend down symmetrically on both sides, towards the intervals separating them. The maximum of their height coincides with the middle portion of the lateral parts. Their arrangement is symmetrical on both sides of the siphonal area.

A more compressed shell, much more slowly increasing whorls and radial direction of the straight, undivided ribs, separate this species from *Ceratites Hidimba* to which it stands in some relationship.

Sutures.—The lobe-line closely resembles that of *Ceratites Hidimba* in its arrangement. The siphonal tubercle is bipartite. The siphonal lobe is divided by a deep indentation into two parts, the margins of which are serrated. The second lateral lobe is on a level with the siphonal lobe. The principal lateral lobe takes the deepest position. They all show strongly incised digitations along their base. The indentations affect the margins of the saddles, and leave but their upper extremities entire. The first auxiliary lobe is strongly indented, and divided along its base by a deeply incised denticulation, resembling in this respect the siphonal lobe. The saddles slope somewhat towards the umbilical region. The first auxiliary saddle is bipartite. The second auxiliary lobe is divided by the umbilical suture.

This species differs in the arrangement of the lobe-line from *Ceratites Hidimba* by the presence of two auxiliary saddles. The quadripartite auxiliary lobe of *Ceratites Hidimba* is developed in this form into two independent, bipartite saddles, separated by a deep, intervening denticulation.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground (Painkandha), 1, Coll. Diener.

13. Ceratites Arjuna, nov. sp., Pl. IV., fig. 1.

Dimensions.

Diameter of the shell	122 mm.
Height of the last whorl	42 „
Thickness of the „ „	37 „
Diameter of the umbilicus	34 „

This beautiful species is distinguished by high, compressed, and slowly increasing whorls, overlapping each other to the extent of half their height, and bordered by softly curved lateral parts. The umbilicus is not completely preserved. So far as one may judge from the fragmentary state of the inner whorls, the shell seems to exhibit considerable egresssion from the spire in its last volution. The siphonal area is gently rounded and not sharply separated from the lateral parts. In the inner whorls an umbilical margin may be noticed, whilst in the last, entirely chambered whorl, no marked margin exists, but the lateral parts bend gradually and with continually increasing convexity down to the umbilical suture.

The last whorl bears 21 radially directed, gently curved ribs. They rise a little above the umbilical margin, attain their greatest height before reaching the middle of the lateral parts, and flatten out in the upper portion of the sides. They are slightly bent forward near the siphonal margin, where they spread considerably. They do not disappear completely when passing the ventral side, so much so, that the siphonal area in a longitudinal section shows a series of very flat broad waves, interrupted by depressions of the same shape. Even near their greatest height, the ribs possess rounded edges. They slope much more gently towards the aperture than to the reverse side, where their slope is steep. They increase in height and thickness as they approach the inner extremity of the body-chamber.

On the siphonal area thin transverse growth-lines may be seen, especially in those places, where the ribs pass it in the shape of flat, broad folds.

Sutures.—The examination of the details of the lobe-line is rather difficult in consequence of the bad preservation of the specimen. In the shape of the sutures *Ceratites Arjuna* differs considerably from all the other mentioned species of the "*Circumplicati*" group. The principal lateral lobe is very deep. The siphonal saddle and the two lateral saddles are situated on almost the same level. Their walls are strongly serrated up to the last entire arch. The second lateral saddle is followed by a very remarkable and long auxiliary lobe, whose denticulations, to the number of six or seven, are perfectly equal in size and shape. The second lateral lobe is but very little deeper than this auxiliary lobe.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 2, Coll. Diener.

14. CERATITES ONUSTUS, OPPEL. Pl. I., fig. 5.

1863. *Ammonites onustus*, Oppel, Palæontologische Mittheilungen aus dem Museum des K. bayr. Staates. 1863, Pl. 77. fig. 2, p. 277.
1865. *Ammonites Blanfordi*, Salter, Palæontology of Niti, Calcutta, 1865, p. 66, Pl. VII., fig. 2.
1865. *Ammonites Thuillieri*, Stoliczka *exparte*, Mem. Geol. Survey of India, Vol. V., Pl. I., p. 57.
1882. *Ceratites onustus*, E. v. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, p. 44.

The only specimen of this species which I have seen, Oppel's type-specimen from the Schlagintweit collection, is the fragment of a chambered whorl, which consists of nearly half a volution. The specimen, to which according to modern practice no specific name ought to have been assigned, is so much damaged, that in the figure (Pl. I. fig. 5) the whorl appears higher at its outer, than at its inner, extremity. In a transverse section of the latter, the proportion of height to thickness is 41mm. to 28mm.

The ventral area is broad and gently rounded, neither carinate nor sharply separated from the lateral parts. The sides are almost flat and in the lower portion of the whorl bend gradually towards the umbilical suture. It is only quite near the latter, that their inclination becomes steeper. From the rounded umbilical margin rise simple radial ribs. Their direction is almost straight towards the siphonal margin, where they terminate without forming any tubercles, but turn slightly forward. The ribs are separated from each other by irregular intervals and are situated asymmetrically to a median plane along the siphonal area.

Sutures.—The arrangement of the sutures is similar to that in *Ceratites Thuillieri*, but differs inasmuch as the saddles are considerably broader in our species. As in *Ceratites Thuillieri*, the denticulations affect the marginal walls of the saddles up to their summits, which alone remain entire. Outside the umbilical suture a bipartite auxiliary lobe and a bipartite saddle is situated.

Locality, number of specimens examined.—Kuling, Spiti, 1, Coll. Schlagintweit in the Palæontological Museum in Munich (Oppel's type-specimen).

Remarks.—Stoliczka (l. c. p. 57) rightly remarks that fragments like Oppel's *Ceratites onustus*, are not worthy of specific names. He declares himself unable to distinguish it from *Ceratites Thuillieri*, an error that can only be explained by Oppel's rather unsatisfactory figure. In these two species, involution and sculpture are so absolutely different, that nobody who has had Oppel's type-specimens in his hands, will identify them for a moment.

A species probably identical with *Ceratites onustus* is *Ammonites Blanfordi*, Salter (l. c. p. 66). The figure (Pl. VI. fig. 2), representing a fragment of a somewhat smaller diameter than Oppel's type-specimen, agrees very well, although in *Ammonites Blanfordi* the sutures are not sufficiently preserved and the first auxiliary lobe especially is not visible. E. von Mojsisovics, who had the opportunity of examining Salter's type-specimen in the British Museum (Natural-history Museum) in London, pronounces its identity with *Ceratites onustus* and notices its affinities with *Ceratites Zezianus* v. Mojs. (Die Cephalopoden der Mediterranen Triasprovinz, Pl. XXXVII., fig. 3, 4, p. 44) from the "Buchensteiner Schichten" of the Mediterranean Trias.

15. Ceratites Vyasa, nov. sp., Pl. VI., fig. 1, 2.

Dimensions.

Diameter of the shell	170 mm.
Height of the last whorl	57 „
Thickness of the „ „	45 „
Diameter of the umbilicus	69 „

This large form seems to be closely allied to *Ceratites onustus*, Oppel, if it is permissible to draw any conclusions from the fragment, which Oppel has thought worthy of a specific name.

The slowly increasing whorls leave a wide, rather shallow umbilicus, and are distinguished by a considerable difference in the shape of the inner volutions and of the last whorl, containing the body-chamber. The inner whorls are very high and almost elliptical in section. In one of the specimens in my collection the height is 27mm., with a diameter of shell of 78mm., and thickness of 14mm. The siphonal part is quite rounded. In the last whorl which overlaps about one-third of the preceding one, the height and thickness of the transverse section increase much more rapidly. In the meantime the body-chamber becomes comparatively less compressed, and its ventral area grows flatter.

The inner whorls are separated from the stair-like umbilicus by a perpendicular, low wall. In the body-chamber the umbilical margin is marked only by a stronger convexity of the lateral parts.

In the specimen figured Pl. VI. fig. 1, one-half of the outer whorl belongs to the body-chamber.

The lateral parts of the inner whorls are provided with straight, radial ribs, directed sometimes slightly obliquely forward, and turning sharply forward near the siphonal margin, where they die out. The ribs are partly simple, partly bifurcate.

The bifurcation takes place in the umbilical margin. Frequently the real ribs are accompanied by narrow striae-like elevations, which may be plainly seen in fig. 2.

The sculpture of the last whorl consists of simple ribs only. They are prominent, roof-like, acute, with sharpened edges, and their slope is much steeper towards the aperture than backwards. They rise near the umbilical margin, become gradually more prominent in the lower portion of the lateral parts, where they are interrupted by a flat, wavy depression, and terminate near the siphonal margin in large, stout elevations. A section along the plane of one of these ribs shows an almost rectangular shape. The ribs stand asymmetrically to the median plane in all the specimens examined. Their direction is not radial as in *Ceratites onustus*, but strongly oblique, nor are they bent forward near the siphonal margin. The intervals which separate the ribs are larger in *Ceratites Vyasa*. In the last half volution the ribs occur to the number of 11.

Sutures.—The lobe-line bears a considerable resemblance to that of *Ceratites onustus*. The saddles are more protracted and a stronger serration affects their walls, leaving but the uppermost extremities entire. Three auxiliary lobes and two short, low, auxiliary saddles stand outside the umbilical suture. The auxiliary lobes are broader than in *Ceratites onustus*, which at the same height of the whorl has but one auxiliary saddle.

Siphuncle.—In the specimen figured Pl. VI. fig. 2, a siphuncle is seen which consists of longitudinal fibres and possesses a similar aspect to that found in *Ceratites Kamadeva*.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground (Painkhánda), 5, Coll. Diener; Bambanag cliffs, Girthi valley, 1, Coll. Diener.

Remarks.—*Ceratites Vyasa* is still more closely allied to *Ceratites Zezianus*, E. v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz, 1882, Pl. XXXVII, fig. 3, 4, p. 44), than *Ceratites onustus*, Oppel. Its shell is less compressed than in the Mediterranean species and the last whorl bears a considerably smaller number of ribs, which are separated by larger intervals.

16. Ceratites sp. ind. ex. aff. C. Vyasa. Pl. VII., fig. 6.

This species, of which only the fragment of an entirely chambered outer whorl is in my possession, may be compared with *Ceratites Vyasa*. This fragment, which comprises about a quarter of a volution, I obtained myself in the Muschelkalk of the Shalshal cliff near Rimkin Paiar Encamping Ground. From *Ceratites Vyasa*, which it resembles in general shape and involution of the shell, it differs by its sculpture and trapezoidal section of the whorls. The lateral parts are almost flat, rounded only near the umbilical region, and diverge considerably towards the siphonal margin. In this fragment the width of the aperture near the siphonal margin is 33mm. to 24mm. near the umbilical margin, the height of it being 4 mm. The flatly convex siphonal area is sharply separated from the lateral parts.

The ribs are broader and more bulky than in *Ceratites Vyasa*. They become very stout near the siphonal margin.

The arrangement of the sutures differs somewhat from *Ceratites Vyasa*. The saddles are broad and bulky. The whole siphonal saddle and a large portion of the principal lateral lobe is situated in the ventral area. The principal lateral lobe is deeply incised. The second lateral saddle is followed by a tripartite auxiliary lobe. The first auxiliary saddle is divided by the umbilical suture.

17. Ceratites nov. sp. ind. Pl. V., fig. 4.

Two fragments of body-chambers from the Muschelkalk of the Shalshal cliff near Rimkin Paiar Encamping Ground belong to this species, whose nearest allies may probably be found amongst the Ceratites of the group of *Ceratites Zoldianus*, E. v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz, Pl. X. fig. 5, 6, p. 39). The proportion of height to width of the aperture is 21 : 16 in the smaller of the two fragments, 28 : 21 in the other. The shell is rather less compressed than in *Ceratites Zoldianus*, which species it resembles owing to its slowly increasing whorls and the character of its sculpture. The lateral parts are flat, converging towards the siphonal margin. The ventral area is flatly rounded.

The sculpture consists of numerous, tolerably broad, radial ribs, slightly curved forward near the siphonal margin. Most of the ribs are simple, in some of them, however, a bifurcation occurs in the lower portion of the lateral parts. The points of bifurcation are marked by tubercle-shaped prominences.

β. Group of the CERATITES NODOSI.

18. (1.) Ceratites Thuillieri,* Oppel. Pl. I., fig. 1, 2.

1863. *Ammonites Thuillieri*, Oppel: Palæontologische Mittheilungen a. d. Museum des Königl. bayr. Staates Stuttgart. 1863, Pl. 77, fig. 3, p. 277.
1865. *Ammonites Thuillieri*, Stoliczka: *ex parte*, Mem. Geol. Surv. of India. V., Pt. I., p. 57.
1866. *Ammonites Thuillieri*, Beyrich: Abhandlgn. Königl. Akad. d. Wiss., Berlin, 1866, p. 109.
1882. *Ceratites Thuillieri*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, p. 30.

Dimensions.	(Pl. I, fig. 1.)
Diameter of the shell	77 mm.
Height of the last whorl	33 „
Thickness of the „ „	24 „
Diameter of the umbilicus	23 „

Ceratites Thuillieri is one of the few species of this genus in the Indian triassic province, which has very close affinities to a form of the Alpine Muschelkalk. There is no other form among the Indian Ceratites so closely allied to a European species, as *Ceratites Thuillieri* is to *Ceratites trinodosus*, E. v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz, Pl. VIII., fig. 5, 6, 7, 9, Pl. XXXVII., fig. 6, 7, p. 29).

The typical form of *Ceratites Thuillieri*, as is characteristically shown in Oppel's

* Professor Oppel named this species after Colonel Thuillier, at that time Surveyor-General in India, but spelt the name incorrectly; the name should be as adopted in this Memoir.

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figure (Pl. I., fig. 1 of this Memoir), agrees in general shape and involution with *Ceratites trinodosus*. The ventral area is broad, gently rounded, not carinate, and covered with thin, slightly forward-bent growth-lines, wherever portions of the shell are preserved. The slightly convex lateral parts bend with a strong convexity from the rounded umbilical margin to the umbilical suture. The umbilicus is rather deep in proportion to the diameter of the shell. The spire imparts a stair-like character to the whorls, which are sharply separated from each other.

As in *Ceratites trinodosus*, the sculpture consists of strong, broad ribs, which terminate near the siphonal margin in more or less well-marked, protracted, forward-bent tubercles. A second series of tubercles coincides with the umbilical margin, from whence the ribs rise. A third line of tubercles appears on the lateral parts a little above the lower third of their height. In Oppel's type-specimen these lateral tubercles form high, much-protracted prominences, near the base of which the ribs often bifurcate. As has been remarked by E. v. Mojsisovics, the augmentation of the ribs by bifurcation outside the line of lateral tubercles is, however, considerably less frequent than in *Ceratites trinodosus*.

In the latter species at least two, but very often even three, marginal tubercles correspond to one lateral tubercle. In Oppel's type-specimen of *Ceratites Thuillieri*, the number of umbilical and lateral tubercles is 23 on the last volution, the number of marginal tubercles 29. In a second specimen from Rimkin Paiar Encamping Ground the proportion of the lateral and marginal tubercles is 17 : 25, in a third specimen 7 : 14 to the last volution. In a fragment from the same locality, single and bifurcate ribs so regularly alternate, that seven umbilical and lateral tubercles correspond to eleven marginal ones. Another specimen (Pl. I., fig. 2) from Rimkin Paiar, however, exhibits a somewhat different sculpture. In this specimen the bifurcation of the ribs is not limited to the lateral tubercles, but occasionally occurs near the umbilical margin. But of the two ribs, rising in the same umbilical tubercle, only one bifurcates a second time in the line of lateral tubercles, the other remains undivided and bears no lateral tubercle, so that the number of umbilical and lateral tubercles remains equal, as seen in the typical forms of *Ceratites Thuillieri*. In this specimen the umbilical and lateral tubercles occur to the number of 11, the marginal tubercles to the number of 22 on one volution.

A characteristic difference between *Ceratites Thuillieri* and *Ceratites trinodosus* consists in the fact—mentioned first by E. von Mojsisovics—that in *Ceratites Thuillieri* the involution of the whorls takes place *outside*, in *Ceratites trinodosus inside* of the spiral line of lateral tubercles.

Sutures.—The arrangement of the lobe-line is similar to that in *Ceratites trinodosus*. The siphonal saddle is broader and lower than the principal lateral saddle and coincides with the marginal tubercles. The two lateral saddles are narrow and elongated. The second lateral lobe is much shorter than the first and stands as deep as the two auxiliary lobes. The first auxiliary saddle is bipartite. Along the base of the first lateral lobe deeply incised narrow digitations are visible. The denticulations affect the marginal walls of the saddles, the upper extremities of

which are slightly serrated, whilst in *Ceratites trinodosus* the upper portion of the saddles remains entire.

Locality, number of specimens examined.—Muth, Spiti, 1, Coll. Schlagintweit, in the Palæontological Museum in Munich (Oppel's type specimen); Shalshal cliff near Rimkin Paiar Encamping Ground, 8, Coll. Diener; Utadura Pass (Johár), 1, Coll. Diener; Sunamarg, Kashmir, 1, Coll. Geological Museum, Calcutta.

Remarks.—*Ammonites Blanfordi*, Salter (Palæontology of Niti, Pl. VI., fig. 2, p. 66), which is identified with *Ceratites Thuillieri* by Stoliczka (l. c. p. 57), belongs most probably to *Ceratites onustus*, Oppel. Another similar fragment, described and figured by Salter (l. c. Pl. VII., fig. 5, p. 63) as *Ammonites Winterbottomi*, has been considered to be a young individual of *Ceratites Thuillieri* by Beyrich l. c. p. 110), whilst Stoliczka (l. c. p. 57; has some doubts as to the identity of the two species. E. von Mojsisovics, who had an opportunity of examining Salter's collection in the British Museum in London, thinks that *Ammonites Winterbottomi* belongs to the genus *Trachyceras*, and has not been collected in the Muschelkalk, but in the overlying strata of upper triassic age.[1]

19. (2.) Ceratites Himalayanus, Blanford. Pl. I., fig. 4.

1863. *Ammonites (Ceratites) Himalayanus*. Blanford: Journal Asiat. Soc. of Bengal, 1863, No. II. Pl. 2, fig. 7, p. 133.

1865. *Ammonites Thuillieri*, Stoliczka: *ex parte*, Mem. Geol. Surv. of India, Vol. V., Pt. I., p. 56.

Dimensions.

Diameter of the shell	37 mm.
Height of the last whorl	19 „
Thickness of the „ „	14 „
Diameter of the umbilicus	7·5 „

Like *Ceratites Thuillieri*, this species, of which I possess only one entirely chambered individual (Blanford's type-specimen), offers many affinities with *Ceratites trinodosus*, E. v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz, Pl. VIII., fig. 5, 6, 7, 9, Pl. XXXVII, fig. 6, 7, p. 29), both in general shape and sculpture. In the last volution 21 marginal tubercles correspond to 10 lateral ones. Outside the lateral row of tubercles a regular augmentation of the ribs occurs, partly by bifurcation, partly by the intercalation of intermediate ribs. The proportion of lateral and marginal tubercles is nearly the same as in *Ceratites trinodosus*. The involution of the whorls likewise takes place inside the spiral line along which the lateral tubercles are arranged, not outside, as in *Ceratites Thuillieri*, Oppel. The umbilical tubercles, if any exist, are but faintly marked, as is the case in the Lombardian variety of *Ceratites trinodosus*.

The ventral part is provided with a distinctly marked keel as in *Ceratites elegans*, v. Mojsisovics (l. c. Pl. IX., fig. 5, 6, p. 31). From the marginal tubercles the ribs continue as prolongations which are decidedly bent forward and towards the keel.

[1] *E. v. Mojsisovics*, "Arktische Triasfaunen." l. c. p. 149.

Sutures.—In shape and arrangement the sutures are similar to those of *Ceratites Thuillieri*, Oppel, although I have not been able to prepare them sufficiently to enable me to make out all details of their denticulations. One of the differences, which distinguish it from *Ceratites trinodosus* and *Ceratites Thuillieri*, consists in the existence of two strongly developed auxiliary saddles outside the umbilical suture. The first auxiliary saddle is an undivided arch. The second auxiliary lobe coincides with the umbilical edge as in *Ceratites elegans*. The marginal walls of the saddles seem to be serrated almost up to the summit.

Locality, number of specimens examined.—Spiti valley (exact locality not known), 1, Coll. of the Asiatic Society of Bengal in the Geological Museum in Calcutta.

Remarks.—Blanford, who first established the present species, has himself now identified it with *Ceratites Thuillieri*.[1] Stoliczka also enumerates it in his list of synonyma of *Ceratites Thuillieri* (l. c. p. 56). In the foregoing description, based on the examination of Blanford's type-specimen, the reader will find, I hope, sufficiently good reasons for considering *Ceratites Himalayanus* a proper species.

20. (3.) Ceratites Kamadeva, nov. sp. Pl. V., fig. 1.

Dimensions.

Diameter of the shell	90 mm.
Height of the last whorl	43 „
Thickness of the „ „	34 „
Diameter of the umbilicus	31 „

This beautiful species, of which I have but one entirely chambered specimen in my collection, resembles in its sculpture *Ceratites subnodosus*, E. v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz, 1882, Taf. X, fig. 9, 10, 11, p. 33), whilst in general shape and involution of the shell it differs remarkably from the Mediterranean form. The whorls are much less involute, and increase more rapidly in height and thickness. In the specimen figured, the height of the last whorl increases from 32 to 43 mm., the thickness from 24 to 34 mm. for one half of the last volution. The transverse section is almost rectangular. The flat ventral area is sharply separated from the lateral parts.

Like *Ceratites subnodosus* and *Ceratites nodosus*, the well-known fossil type of the German Muschelkalk, this species possesses, in its adolescent stage, strong umbilical tubercles and a well-marked umbilical edge. In later stages of growth the umbilical tubercles completely disappear, the umbilical edge becomes gradually rounded, and the lateral parts slope in a decided curve towards the umbilical suture.

The ornamentation of the lateral parts is especially remarkable. Strong, radial ribs, which become slightly flexuous near the siphonal margin, cover the upper portion of the sides and terminate in tubercle-shaped prominences, a little above

[1] Palæontology of Niti, p. 106.

the lower third of the height of the lateral parts. From this spiral line of lateral tubercles, which but exceptionally exhibit the features of genuine tubercles, the ribs continue as faintly marked folds towards the umbilical margin. In the inner whorls they bear stout umbilical tubercles which gradually disappear in later stages, as has been mentioned above. The transverse section of the ribs is rounded. They slope more gently on the side towards the aperture than on the reverse side, which is steeper. They terminate near the siphonal margin in strongly developed, obliquely protracted tubercles. The number of the lateral and marginal tubercles is equal. Intermediate ribs, as they occur in *Ceratites subnodosus* have not been noticed in the present specimen. Most of the ribs become more prominent half-way between the lateral and marginal tubercles, but not sufficient prominences are formed to impart the character of a second chain of lateral tubercles. The ribs do not pass over the siphonal area, which remains entirely smooth.

Siphuncle.—In the ventral area of the last whorl the siphuncle is clearly visible for a distance of 12 mm. It has the shape of a string and consists of longitudinal, frequently anastomosing fibres, coloured more darkly than the neighbouring parts of the matrix. It agrees perfectly with the figures and descriptions of some Arctic Ceratites given by E. v. Mojsisovics ("Ueber die Structur des Sipho bei einigen triadischen Ammoneen," Neues Jahrbuch f. Mineralogie 1885, Bd. II., p. 151).

Sutures.—The siphonal lobe is distinguished by its rather high position and divided by a high, delicately serrated, siphonal tubercle. The saddles are serrated up to their apices, which form entire arches. The siphonal saddle is shorter than the principal lateral, but higher than the second lateral saddle. The base of the first auxiliary lobe ends in two sharp points. Two auxiliary saddles are situated outside the umbilical suture.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground (Painkhanda), 1, Coll. Diener.

21. (4.) Ceratites Kuvera, nov. sp. Pl V., fig. 2.

Dimensions.

Diameter of the shell	85 mm.
Height of the last whorl	33 "
Thickness of the " "	21 "
Diameter of the umbilicus	28 "

This species somewhat resembles *Ceratites Thuillieri*, Oppel, in general shape of the shell, involution and sculpture. The whorls, however, increase more slowly than in the latter species. The ventral area is flat and sharply separated from the lateral parts, as in *Ceratites Kamadeva*. The inner whorls are but imperfectly preserved. Near the inner extremity of the last whorl the sculpture of the lateral parts is formed by bifurcate ribs, which rise from the umbilical margin, and bifurcate into strong lateral tubercles. This series of lateral tubercles stands a little

above the lower third of the height of the last whorl. In later stages of growth the ribs remain undivided. They terminate in stout, marginal tubercles, which are prolonged in the direction of the aperture.

The involution of the whorls takes place far outside the spire of lateral tubercles, and near the lower third of the distance between the lateral and marginal tubercles.

The only specimen available is somewhat distorted and drawn out like all specimens from Kalapani, and is entirely chambered.

Sutures.—There are decided differences between our species and *Ceratites Thuillieri* in the arrangement of the lobe-line. The lateral lobes are considerably enlarged at their base, whilst they contract towards their upper portion. The principal lateral lobe shows plainly deep digitations, which affect likewise the marginal walls of the saddles. The extremely short siphonal saddle coincides with the marginal tubercles. The principal lateral saddle is oblique, and slopes towards the marginal side. The first, serrated, auxiliary lobe is followed by a bipartite auxiliary saddle, and a long sutural lobe, which is intersected by two deep indentations.

Locality, number of specimens examined.—North of Kalapani, Kali River valley (Byans), 1, Coll. Griesbach.

γ. Group of the CERATITES SUBROBUSTI.

22. (1.) Ceratites truncus, Oppel. Pl. I., fig. 7.

1865. *Ammonites truncus*, Oppel: Palaeontologische Mitth., Pl. 86, fig. 3, p. 292.
1882. *Ceratites truncus*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, p. 44.
1886. *Ceratites truncus*, E. v. Mojsisovics: Arktische Triasfaunen, p. 21.

Oppel's type-specimen is the fragment of an outer whorl, consisting of four chambers, distinguished by an almost elliptical section. The thickness of the whorl is 34 mm., its height above the umbilical suture 40 mm. The lateral parts curve gradually towards the umbilical suture, as well as towards the siphonal area, and are separated from both of them by a sharp border. The ventral area is broad and flatly rounded. If one may judge from the curve of the fragment, the involution of the whorls seems to correspond approximately to that of *Ceratites Vyasa*.

The sculpture of the fragment is very remarkable. The lateral parts are provided with strong, radial ribs, which begin near the umbilical margin as faintly marked folds, and terminate near the siphonal margin in very stout, prominent tubercles. A second row of lateral tubercles of equal size and knob-like shape, coincides with the lower third of the height of the sides of the whorls. The intervals between the roof-like ribs, form regular arches in their transverse sections, as in *Ceratites Hidimba*. To a median plane through the siphonal area the ribs stand asymmetrically.

Sutures.—The extraordinarily long principal lateral lobe is much deeper than the siphonal and the second lateral lobe. The large rounded saddles are similar in

height, and not serrated in their upper portions. The denticulation affects the marginal walls only in the lower half of their height. The lobes are provided with deep, strongly developed digitations at their base. Two auxiliary lobes and one simple auxiliary saddle stand outside the umbilical suture. The second auxiliary lobe is serrated.

Locality, number of specimens examined.—Kuling, Spiti, 1, Coll. Schlagintweit, in the Palæontological Museum in Munich, Oppel's type-specimen.

Remarks.—According to the opinion of E. von Mojsisovics (Arktische Triasfaunen, p. 21), *Ceratites truncus* belongs to the group of the *C. subrobusti*, at least in so far as one may be able to decide from its rather fragmentary state of preservation.

23. (2.) CERATITES, nov. sp. ex aff. C. SUBROBUSTUS. Pl. V., fig. 6.

This fragment of an entirely chambered outer whorl does not permit exact measurements of its dimensions. The height of the whorl at its aperture is 14 mm., the thickness 12 mm. The whorls are higher than in *Ceratites subrobustus*, E. v. Mojsisovics (Arktische Triasfaunen. Pl. VI, fig. 1, p. 44), to which ours species is closely allied, especially with reference to its sculpture and sutures.

The lateral parts are strongly convex and bent towards the umbilicus in a steep curve. The siphonal area is somewhat raised into the shape of a roundish keel. Near the middle of their height the sides bear very prominent umbilical tubercles, in the numerical proportion of seven to one-half of the outer whorl. From these umbilical tubercles, distinctly marked ribs run towards the umbilical suture, as well as towards the siphonal margin, where they terminate in strong tubercles. In the present fragment a bifurcation of the ribs occurs three times in the umbilical tubercles; 8 marginal correspond to 5 umbilical tubercles.

Sutures.—The arrangement of the sutures is very similar to that in *Ceratites subrobustus*, with the exception of a second auxiliary lobe which is situated outside the umbilical suture. Only a part of the second lateral lobe is placed within the umbilical margin, whilst the umbilical tubercles are divided by the inner margin of the principal lateral saddle. The siphonal saddle coincides with the marginal tubercles as in *Ceratites subrobustus*. The siphonal lobe is less deep than the principal lateral lobe. The lobes are deeply serrated at their base. The indentations reach almost to the upper extremities of the saddles, which alone remain entire, whereas in *Ceratites subrobustus* a lower stage of development is marked by its less deeply serrated lobes and entire saddles. In the siphonal lobe of the present species 7 denticulations are counted on each side of the siphonal tubercle, and 8 in the principal lateral obe.

Locality, number of specimens examined.—Right border of Topidunga valley, near Topidunga Encamping Ground (Johár), 1, Coll. Diener.

24. (3.) CERATITES sp. ind. et aff. C. MIDDENDORFI. Pl. V, fig. 7.

Dimensions.

Diameter of the shell	37 mm.
Height of the last whorl	15 „
Thickness of the „ „	15 „
Diameter of the umbilicus	12 „

The only individual of this species, which was collected by myself in the Muschelkalk of the Shalshal cliff near Rimkin Paiar Encamping Ground, is unfortunately in too bad a state of preservation to allow of any specific determination. In its general shape it agrees perfectly with *Ceratites Middendorfi*, Graf Keyserling, from the Siberian Trias[1]. Its transverse section resembles that of the specimen figured by E. v. Mojsisovics in Pl. II., fig. 13. The lateral parts are greatly rounded, but become strongly curved towards the siphonal area. The height and width of the aperture are the same. The umbilical margin is marked by a strong convexity of the sides and by prominent tubercles, of which there are four in the last half volution. In the siphonal area transverse wrinkles may be noticed. The inner whorls are not preserved.

Sutures.—Unknown.

δ. GROUP OF THE CERATITES GEMINATI.

25. (1.) CERATITES NOV. SP. IND. Pl. V., fig. 3.

The only and rather imperfect fragment of this highly interesting species, is distinguished by a true keel, bordered by marked furrows. The proportion of height and thickness in a transverse section is as 8 : 5. The siphonal area is comparatively narrow, the sides are moderately rounded.

The sculpture of the lateral parts consists of numerous, nearly straight ribs, bent slightly forward near the siphonal margin. The umbilical region is not sufficiently well preserved to decide whether the ribs remain undivided, as I believe, and as is represented in my figure (Pl. V. fig. 3) or whether some of them bifurcate near the umbilical margin.

In the present specimen the sculpture is interrupted by five transitional mouth-borders, which rise in the umbilical region from the fore-part of the ribs, pass over the latter themselves near the siphonal margin, in the shape of strongly developed parabolic ears, and bending obliquely forward terminate towards the siphonal area.

Sutures.—Not known.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

Remarks.—No close relationship seems to exist between this form and the rest of the species of this group, described by E. v. Mojsisovics from the Spitzbergen Muschelkalk.

[1] E. v. Mojsisovics: Arktische Triasfaunen, l. c. Pl. II, fig. 12, 13, p. 38.

26. (2) Ceratites sp. ind. (?) Pl. V. fig. 5.

It seems rather doubtful whether it may be permissible to look upon this fragment of a body-chamber, as belonging to the group of the *Ceratites geminati*. A greatly corroded elevation in the middle of the ventral area may be supposed to represent a keel, as in a transverse section no separating area or fissure is visible between it and the rest of the shell. It may prove to be an inorganic deposit, however, which does not belong to the shell at all.

The lateral parts are low, flat and sharply separated from the broad ventral area. The siphonal part is strongly convex. The ribs rise from faint prominences near the umbilical margin. Their direction is radial in the lower portion of the lateral parts, where they swell into slight tubercles. In the upper portion of the sides they become falciform, and are strongly bent forward near the siphonal margin. They gradually die out, when passing over to the ventral area. Between two principal ribs an intermediate one is intercalated, which runs in a falciform direction towards the lateral tubercles, but without joining them completely.

The proportion of height and thickness of the aperture is 26 : 20, the height of the (doubtful) keel not counted.

Sutures.—Not known.

Locality, number of specimens examined.—Bambanag cliffs (Girthi valley), 1, Coll. Diener.

Sub-genus: DANUBITES, E. v. Mojsisovics.

The sub-genus *Danubites* was established by E. v. Mojsisovics (Die Cephalopoden der Hallstætter Kalke Vol. II., 1893, p. 398) for the two sections of the *Ceratites obsoleti* and *Ceratites Floriani*,[1] distinguished by barely overlapping whorls and a transverse sculpture, very similar to that in *Celtites*, E. v. Mojsisovics. *Danubites*, already known in the Mediterranean and Arctic-Pacific Trias, attains a certain importance in the lower Trias of the Himálayas, which I may note in anticipation of the publication of a monograph on the Cephalopoda of the Himálayan lower-triassic deposits. In the Muschelkalk of the main-region it has, however, only one typical representative, *Danubites Dritarashtra*, which is very closely allied to the Mediterranean group of *Danubites Floriani*, Mojs. Both its transverse sculpture, which consists of single radial ribs, confined to the lateral parts and interrupted by a thin thread-like siphonal keel, and the remarkably great distance of its septa, mark peculiar characteristics of our Indian species and of the Mediterranean forms of this group.

[1] *Danubites Floriani* was originally united with *Celtites* by E. v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz p. 145.), as the length of its body-chamber was not known at that time. Later examinations afforded evidence that it belongs to *Ceratites* by reason of its short body-chamber. (E. v. Mojsisovics "Über einige Japanische Trias-Fossilien," Beiträge zur Palæontologie Oesterreich-Ungarns, etc. Wien, Vol. VII, 1888, p. 170.)

1. Danubites Dritarashtra, nov. sp. Pl. VIII. fig. 1.

Dimensions.

Diameter of the shell	49 mm.
Height of the last whorl	11·5 „
Thickness of the „ „	10 „
Diameter of the umbilicus	20 „

This form, belonging to the Mediterranean group of *Danubites Floriani*, v. Mojsisovics, is distinguished by its numerous, very slowly increasing whorls. Even *Danubites retrorsus*, E. v. Mojsisovics (Die Cephalopoden der Mediterranen Trias-provinz Pl. XXXIV. fig. 3, p. 146), which in this respect bears a greater affinity to our species than any other form of this group, possesses only a smaller number of whorls in specimens of the same diameter.

The whorls overlap each other but very slightly. They are higher than broad in full grown specimens, whilst in young individuals a transverse section is of equal height and width. The ventral area is steeply rounded and provided with a median, thin, thread-like elevation, taking the place of a keel. The front-view of the specimen figured in Pl. VIII., fig. 1, does not give a correct idea of its shape, the specimen being slightly distorted and drawn out so much, that its ventral part looks rather unnaturally sharpened. An examination of the body-chamber of this and other specimens clearly shows, that the siphonal area, although more convex than in *Danubites Floriani*, E. v. Mojsisovics (l. c. Pl. XXVIII. fig. 5, 6, 7, XXXI. fig. 4, p. 145), is not sharpened. The existence of a delicate, thread-like keel imparts, it is true, to the siphonal area the character of a somewhat obtuse edge, owing to its rather steep convexity. It seems doubtful, however, whether the oblique, elliptical shape depends entirely on a later deformation through pressure, as it is peculiar to all the specimens examined. But as specimens of different species from the same locality exhibit also this drawn out elliptical shape, being imbedded in soft calcareous shales, subjected to cleavage, this form may possibly be considered as accidental, and not characteristic of the species.

The lateral parts bend towards the umbilical suture in a very steep curve. They are covered with numerous, strong, simple, radial ribs which correspond on both sides of the siphonal keel. The ribs, of which about 35 are situated in one volution, are all single near the umbilical margin, already strongly developed, and then swell out to their greatest elevation in the middle portion of the sides. In the lower portion of the lateral parts they are narrow and terminate in a rounded edge. Near the siphonal margin they become considerably enlarged, as their elevation decreases. On both sides of the median siphonal keel, the sculpture is interrupted. In the specimen figured, Pl. VIII. fig. 1., the last half of the outer whorl belongs to the body-chamber.

Sutures.—Very similar to those of *Danubites Floriani*, but the denticulations at the base of the lobes are more developed. The siphonal lobe ends in two points; the principal lateral lobe is serrated up to the middle of the height of the bordering

saddles, with two deep indentations at its base. The second lateral lobe is bipartite and stands much higher than the deeply incised principal lateral lobe. Its height is almost equal to that of the first auxiliary lobe, the inner margin of which is touched by the umbilical suture. The siphonal saddle is larger than the principal lateral saddle.

The distance of the septa is unusually large even quite close to the body-chamber. In the figure mentioned above, the distance of the two last septa, followed by the body-chamber, is 8 mm.

Locality, number of specimens examined.—Utadurrha-Pass (Johár), in dark, calcareous shales, 3, Coll. Diener.

Remarks.—In *Danubites Dritarashtra* the lobe-line has attained a somewhat higher stage of development, than in any form of the Mediterranean group of *Danubites Floriani*. In this respect our species shows a close affinity to *Danubites Naumanni*, v. Mojsisovics ("Über einige Japanische Trias-Fossilien" l. c. p. 169, Pl. II. fig. 1) from the Trias of Japan, which has been found in geologically younger deposits.

Sub-genus: JAPONITES, E. v. Mojsisovics.

In his memoir on some triassic fossils from Japan, E. von Mojsisovics described and figured a species of *Ceratites*, *Ceratites planiplicatus* [1] distinguished by a sculpture peculiar to the *Dinarites* or *Ceratites spiniplicati* and by dolichophyllic sutures. This species, with which may be compared *Ammonites runcinatus*, described and figured by Oppel in 1865[2] is considered now by E. v. Mojsisovics to be the type of a special sub-genus, *Japonites.*[3]

According to the diagnosis of *Japonites planiplicatus* the following may be pointed out as sub-generic characters. Discoidal, flat shell, consisting of very numerous, slowly increasing whorls, overlapping each other but little, a wide umbilicus, a sculpture similar to that of the *Dinarites spiniplicati*, completely interrupted near the siphonal area, dolichophyllic sutures, a remarkable disproportion in the development of the high, deeply incised principal saddles and the low auxiliary saddles, scarcely surpassing the dimensions of the larger denticulations at the base of the principal lobes. Another character, which the forms included in this subgenus have in common, is the club-like shape of the lateral saddles which become enlarged in their upper portions.

In the Indian triassic province the sub-genus *Japonites* is represented by three species, *Japonites runcinatus*, Oppel, *Japonites Sugriva*, nov. sp., *Japonites Chandra*, nov. sp. Of these *Japonites Sugriva* is very closely allied to *Japonites planiplicatus*, Mojs., from the Trias of Japan, especially if we consider the development of the sutures.

[1] *E. v. Mojsisovics* "Über einige Japanische Trias-Fossilien: Beiträge zur Geologie Oesterreich-Ungarns und des Orients; herausgegeben von. E. v. Mojsisovics und M. Neumayr. Vol. VII. Wien, 1888, Pl. IV. p. 170.

[2] *A. Oppel*, Palaeont. Mittb. Vol. I. Pl. 84, fig. 2, p. 290.

[3] *E. v. Mojsisovics.* "Die Cephalopoden der Hallstætter Kalke," II. 1893, p. 3, 503, 504.

Japonites forms probably a faunistic element exclusively peculiar to the Arctic-Pacific and Indian triassic provinces, although this fact is not yet beyond every doubt. Among the *Ceratitidæ* from the Bosnian Muschelkalk, described by F. v. Hauer (Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien. I. Neue Funde aus dem Muschelkalk von Han Bulog bei Sarajevo. Denkschr. Kais. Akad. d. Wiss. in Wien, Math.-Nat. Cl. LIX., 1892), *Ceratites striatus* (l. c. Pl. IV. fig. 1, p. 263), *Ceratites labiatus* (Pl. V. fig. 1, p. 266), *Ceratites evolvens* (Pl. V. fig. 3, p. 265) particularly resemble *Japonites* in their involution, sculpture and structure of the lobe-line. On the other hand, the existence of labiæ or contractions of the inner whorls of *Ceratites labiatus* seems to point to a close affinity between the three species mentioned above, with the genus *Proteites*, completely isolated up to now in the triassic deposits of Bosnia. Neither has the occurrence of longitudinal striae in the sculpture of *Ceratites labiatus* and *Ceratites striatus* been noticed in any of the species of *Japonites*. The relationship of *Proteites* to the group of *Ceratites decrescens*, v. Hauer (Die Cephalopoden des bosnischen Muschelkalkes von Han Bulog bei Sarajevo. Denkschr. Kais. Akad. d. Wiss. Wien LIV., 1887 Pl. V. fig. 3, p. 24), closely allied to *Ceratites evolvens*, has been clearly pointed out by F. v. Hauer himself.

1. JAPONITES SUGRIVA, nov. sp. Pl. VII, fig. 1.

Dimensions.

Diameter of the shell	114 mm.
Height of the last whorl	30 „
Thickness of the „ „	29 „
Diameter of the umbilicus	60 „
Height of the last whorl in the place of its greatest applanation	26 „
Thickness of the last whorl in the place of its greatest applanation	25 „
Corresponding diameter of the shell	93 „
Corresponding diameter of the umbilicus	48 „

In involution, sculpture and arrangement of the sutures the present species is closely allied to *Japonites planiplicatus*, v. Mojsisovics (l c. Pl. IV. p. 170) from the triassic slates of Okatsuhama in Japan. *Japonites Sugriva* is distinguished by the obliquely elliptical shape of its shell, more slowly increasing whorls, which overlap each other scarcely to the third part of their height, and a wider, and shallower umbilicus.

The greatest thickness of the cordiform transverse section coincides with the umbilical margin. The sides are curved into a pointed arch and converge into a sharp siphonal area. In *Japonites planiplicatus* the siphonal part is sharpened in a similar manner, although in the specimen from Japan it seems rather difficult to decide how much of this is owing to the distortion and compression in the soft matrix. The umbilical margin is low and steeply rounded.

The inner whorls have suffered considerably owing to the matrix having splintered. In some places, however, the sculpture is clearly visible. It consists of very flat, broad folds separated by intercostal intervals of equal size. In the last, entirely chambered whorl the intercostal intervals can only be traced in the lower

portion of the lateral parts as very flat, radial furrows. They are more numerous but less strongly developed than in *Japonites planiplicatus*, which otherwise possesses the same simple sculpture, peculiar to the spiniplicate *Dinarites* and *Ceratites* of the Arctic Trias. The broad, flat folds, of which there are about 20 in the last volution, are somewhat more prominent near the umbilical margin, but are still very far from forming the tubercle-shaped elevations, which occur in a very large number of *spiniplicati*. The upper portion of the lateral parts is perfectly smooth. No fold touches the siphonal edge. In the inner circuits the sculpture is rather more strongly marked than in the last whorl.

Sutures.—Both in the arrangement and in the details of the dolichophyllic sutures there is great similarity to *Japonites planiplicatus*. The siphonal lobe is narrow and extraordinarily short, provided with three sharp points at its base and divided by an unusually high siphonal tubercle. The siphonal saddle is more slender than in *Japonites planiplicatus* and lower than the principal lateral saddle. The two lateral saddles are enlarged, club-shaped above, and one is provided with large digitations. A phylloid prominence is noticed at the inner margin of the second lateral saddle. The reduced auxiliary saddles are in sharp contrast to the large principal saddles owing to their rudimentary development. In the broad umbilical lobe three auxiliary saddles may be distinguished, among which the central one is bipartite. The principal auxiliary lobe terminates in two points and, as in *Japonites planiplicatus*, is placed lower down than the bipartite second lateral lobe. The principal lateral lobe is the deepest and ends in a central point.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

2. Japonites Chandra, nov. sp. Pl. X., fig. 4.

Dimensions.

Diameter of the shell	77 mm.
Height of the last whorl	23 „
Thickness „ „ „	21 „
Diameter of the umbilicus	38 „

Like the preceding species, *Japonites Chandra* possesses a discoidal shell, consisting of numerous whorls, overlapping each other scarcely to one third of their height, and a wide umbilicus. It differs remarkably, however, in shape from *Japonites Sugriva*, by its normal spiral. The transverse section is alike in both species, of nearly equal height and thickness, and in the shape of a pointed arch, with slightly curved sides. The siphonal area is highly rounded near the beginning of the last whorl, but sharpened in the body-chamber. The whorls have their greatest thickness near the umbilical margin, which is higher than in *Japonites Sugriva*, and imparts to the umbilical region a less shallow character.

Three-fourths of the last whorl belong to the body-chamber. In the outer extremity of the last whorl the mouth-border seems to be marked by a falciform, wavy transverse plane in the matrix. But as it coincides with a plane of cleavage, crossing the whole specimen, it may perhaps be accidental only.

The sculpture, visible only in the last whorl, consists of extremely delicate, wavy folds which bend gently backwards and disappear near the siphonal edge. As the surface of the specimen is partially corroded, this delicate radial sculpture has been preserved only in the place noted in the figure.

Sutures.—Dolichophyllic. Siphonal lobe very short and narrow, siphonal saddle slender and lower than the principal lateral saddle. The upper part of the latter is individualised by a deeply incised digitation at its inner margin. The second lateral saddle is of equal height with the siphonal saddle and provided with a phylloid prominence at its inner side. The large principal saddles are followed by an umbilical series of indentations, representing the auxiliary lobes and saddles. Among them only the bipartite first auxiliary lobe can be clearly distinguished. *Japonites Chandra* differs from *Japonites Sugriva* and *Japonites planiplicatus* by the position of the second lateral lobe, which is placed lower than the first auxiliary lobe. The low position of the first auxiliary lobe in the two preceding species cannot therefore be considered as a sub-generic character of *Japonites*.

The sutures marked in the figure (Pl. X. fig. 4) are the large septa preceding the body-chamber.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

3. Japonites runcinatus, Oppel, Pl. VII., fig. 2.

1865. *Ammonites runcinatus*, Oppel: Palaeontologische Mittheilungen aus dem Museum des bayr. Staates I. Pl. 84. fig. 2, p. 290.

1888. *Ceratites (?) runcinatus*, E. v. Mojsisovics, "Uber einige Japanische Trias-Fossilien" Beiträge zur Palaeontologie Oesterreich-Ungarns und des Orients, herausgegeben von E. v. Mojsisovics und M. Neumayr, VII. p. 171.

The outlines of the only individual of this species, an entirely chambered fragment of half a whorl, allow of the supposition, that in general shape and involution this form may resemble *Japonites Chandra*. The whorl overlaps the preceding one to the extent of one quarter of its height. The height of the transverse section is 24mm. Its width may be estimated at 13mm., but this cannot be determined with certainty, as only one of the lateral parts of the shell is preserved. The siphonal area is not sharp as in the other species of *Japonites* but moderately rounded. The sides are flatly convex and slope gradually towards the umbilicus. In spite of many injuries, which the surface of the shell has suffered, flat elevations, taking the shape of broad folds, may be recognised in the lower portion of the lateral parts. They are, it is true, so indistinctly marked, that they could not be represented in the drawing (Pl. VII. fig. 2) any more than in Oppel's figure. Their occurrence, however, clearly proves, that in *Japonites runcinatus* the same arrangement of sculpture prevailed as in other congeneric forms.

Sutures.—As has already been remarked by E. v. Mojsisovics, the lobe-line exhibits an arrangement peculiar to *Japonites*, although there is less complication

in the details of the sutures. To the long, slender, principal saddles rudimentary auxiliary saddles correspond, which unite with the first auxiliary lobe to form one single, broad umbilical lobe. The siphonal lobe is very broad, much deeper than in *Japonites Sugriva* and *Japonites Chandra* and divided by a high siphonal tubercle. Of the principal saddles, only the first lateral one shows continuous, but slightly serrated, outlines in its upper part. The siphonal saddle is perfectly dolichophyllic and has deep, tooth-like digitations. The second lateral saddle is provided with a phylloid prominence at its inner margin, as in the two preceding species. The second lateral lobe is placed on the same level as the first auxiliary lobe. In Oppel's figure the position of these two lobes is represented incorrectly.

Locality, number of specimens examined.—Shangra, east of Puling, Hundés, 1, Coll. Schlagintweit in the Palæontological Museum in Munich, Oppel's type-specimen.

Family: *TROPITIDÆ.*

Genus: ACROCHORDICERAS, Hyatt.

Of this genus,—not known from the Muschelkalk of the Himálayas up to now—two species have been lately discovered, which bear no nearer relationship to any form of the Alpine Muschelkalk.

1. Acrochordiceras Balarama, nov. sp. Pl. VII. fig. 3.

Dimensions.

Diameter of the shell	27 mm.
Height of the last whorl	11 „
Thickness „ „ „ „	16 „
Diameter of the umbilicus	8 „

The unusually thick whorls, in which this form differs from all congeneric species of the Mediterranean Trias, enclose a proportionately wide umbilicus. Near the umbilical suture rise strongly developed, broad ribs, partly bifurcating near the umbilical margin, partly remaining undivided. The sculpture extends uninterruptedly across the broad, rounded siphonal area, where the ribs attain their greatest elevation. Only in the last pair of ribs, arising from bifurcation near the umbilical margin, the point of bifurcation is marked by an umbilical tubercle. As the transverse diameter of the specimen is 26mm. at the point at which this umbilical tubercle occurs, the latter forms an element of sculpture but very lately acquired by this species, as is the case in *Acrochordiceras Carolinæ* v. Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz Pl. XXVIII, fig. 14, Pl. XXXVI, fig. 3, p. 141). In the last third portion of the outer whorl two simple intermediate ribs are inserted between two bifurcating ribs.

The whorls have their greatest width near the point of bifurcation of the ribs. The height of the umbilical wall is 4·5mm. (5·5mm. the height of the tubercle in-

cluded) near the extremity of the last whorl. The slope from the umbilical margin towards the umbilical suture is very steep. The arrangement of the ribs is symmetrical to a median plane. Only in the last portion of the outer whorl the details of the sculpture are well exhibited.

Sutures.—Not known.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

2. Acrochordiceras Joharense, nov. sp. Pl. VII. fig. 4.

The only specimen of this species is unfortunately incomplete and somewhat distorted through pressure. As I have not been able to take exact measurements, I must refer to the figure for dimensions and the general outline of the shell.

In this species the whorls seem to be a little higher than in *Acrochordiceras Balarama*; the width of the transverse section, however, still exceeds its height. The umbilicus is tolerably wide. The umbilical margin is lower and less steeply inclined towards the umbilical suture. Near the umbilical margin strongly developed tubercles rise near the points, where the dichotomous ribs bifurcate. They occur, however, in a considerably smaller number than the single ribs, bearing no umbilical tubercles. With a diameter of the shell of 38mm, four intermediate ribs occur between two pairs of ribs each bearing an umbilical tubercle. In a later stage of growth the number of intermediate ribs still increases, but the base of the umbilical tubercle sometimes becomes so large as almost to touch the next intermediate rib. A mere superficial examination therefore produces the impression, that occasionally even more than two ribs were united into one umbilical tubercle.

The strong, coarse ribs pass over the slightly flattened ventral area in a straight line and without diminishing in size. The greatest thickness of the whorls coincides with the row of umbilical tubercles as in *Acrochordiceras Balarama*. From the latter, *Acrochordiceras Joharense,* however, differs not only by its sculpture, but also by its whorls, which increase much more slowly. The outer extremity of the last whorl is not sufficiently well preserved to decide whether a portion of it does or does not belong to the body-chamber.

Sutures.—In general structure and arrangement of the sutures a remarkable similarity may be noticed with the lobe-line of a species of *Acrochordiceras* from the Bosnian Muschelkalk, described and figured by F. von Hauer (Die Cephalopoden des bosnischen Muschelkalkes von Han Bulog bei Sarajevo, Denkschr. Kais. Akad. d. Wiss. Wien LIV. Bd., 1887, Pl. 5, fig. 2 c.).[1] The figure Pl. VII. fig. 4 c. represents the lobe-line of a specimen of a transverse diameter of 45

[1] It has already been remarked by E. v. Mojsisovics (Die Cephalopoden der Hallstätter Kalke II. Bd., 1893 p. 813) that the identification of this species with *Acrochordiceras Damesi* Noetling by F. v. Hauer will not stand a severe test.

mm. The siphonal lobe is deep and narrow and ends in a long drawn out point. The siphonal tubercle reaches half way up the siphonal saddle. The position of the principal lateral lobe is a very low one. This lobe terminates in long, narrow denticulations. Indentations affect the marginal borders of the saddles, the upper extremities of which are slightly serrated. The siphonal and the principal lateral saddles are of equal height. Two broad, deeply serrated auxiliary lobes are separated by a broad serrated saddle. A second auxiliary saddle of very small size stands outside the umbilical suture.

Locality, number of specimens examined.—South slope of Utadura Pass 1, Coll. Diener.

Genus : SIBIRITES, E. v. Mojsisovics.

The genus *Sibirites*, known in the Himálayas up to now from upper triassic strata only, is represented in the dark earthy limestone at the base of the Muschelkalk (zone of *Rhynchonella semiplecta* according to Griesbach[1]) by a richly ornamented species, which bears some affinity to the group of *Sibirites pretiosus* v. Mojsisovics from the Olenek-strata of Siberia.

The presence of this genus in the lower Muschelkalk of the Central Himálayas is of some interest. From Griesbach's section of the Shalshal it was known that *Sibirites* occurs in the upper triassic strata of the Himálayas, and in 1892 our expedition succeeded in discovering a good many species of this genus together with *Halorites*, *Jovites*, *Juvavites*, *Sirenites*, *Choristoceras*, *Cyrtopleurites* and other juvavic types in the upper triassic rocks of the Bambanag cliffs (Girthi valley). Below these beds with *Sibirites* a great mass of upper triassic rocks (*Daonella* beds of Griesbach) follows, characterised by the presence of *Sagenites*, *Cladiscites*, *Arcestes*, which has not yielded any species of *Sibirites*. Nor does *Sibirites* occur in the principal mass of the Muschelkalk or in the crinoid limestone, representing a homotaxial equivalent of the Alpine *Aonoides* beds in the Shalshal cliff. The period of its intermittence therefore comprises the entire upper Muschelkalk and the lower stages of the upper Trias. To what region *Sibirites* retired during this period of intermittence we do not know.

1. Sibirites Prahlada, nov. sp. Pl. VII., fig. 5.

Dimensions.

Diameter of the shell	23 mm.
Height of the last whorl	9 „
Thickness „ „ „	10 „
Diameter of the umbilicus	9 „

This remarkable species is characterised by slowly increasing whorls, which overlap each other but very little, and by a broad rectangular transverse section.

[1] *C. L. Griesbach*, "Geology of the Central Himálayas" Mem. Geol. Surv. of India, XXIII., 1891. p. 71,72.

The proportion of height to width of the latter is very similar in *Sibirites pretiosus* v. Mojsisovics (Arktische Trias-Faunen l. c. p. 61, Pl. X. fig. 10).

The affinities of *Sibirites Prahlada* to the Siberian species are strong, although considerable differences, especially owing to the richer ornamentation of the Indian form, separate them. The ventral area is broad, flattened, and includes an obtuse angle with the strongly curved lateral parts.

The rich, prominent sculpture consists of broad, straight lateral ribs, which reach to the upper third of the lateral parts, where they become divided by strongly developed lunular tubercles. These lunular tubercles (Pl. VII. fig. 5, e.) take the shape of small half-moon-like shields which slope gently from their concave side, whilst their convex part is bordered by steep walls. The bifurcating ribs become a little fainter near the lunular tubercles which mark the point of bifurcation, and pass over the siphonal margin, with a strong forward curve. They meet in a median line of the ventral area, forming the half of a circle with a radius of 3mm, its convexity being turned forward, whilst in *Sibirites pretiosus* and *Sibirites Eichwaldi* Keyserling (E. v. Mojsisovics l. c. Taf. X. fig. 1-9, p. 59), the ribs alternately meet at an acute angle in the middle of the siphonal area. Near the siphonal margin some of the bifurcate ribs become more prominent. In a more advanced stage of growth, these points may be distinguished by spines or tubercles as in the two Arctic forms of *Sibirites* before mentioned.

As the whorls overlap each other only to a very slight extent, the involution takes place far outside the lunular tubercles. The point of bifurcation of the lateral ribs is consequently not concealed by the outer whorl. There are 15 principal ribs on the last whorl and within the spiral line along which the lateral lunular tubercles are situated.

Sutures.—The very simple sutures point to the same stage of development as in the congeneric forms of the Arctic-Pacific province of the Trias. The siphonal lobe is placed nearly as deep as the principal lateral lobe and is simply divided by a short siphonal tubercle, without exhibiting any trace of denticulation. The principal lateral lobe, coinciding in its position with the lunular tubercles, appears slightly serrated under a magnifying glass. The siphonal saddle is distinguished by its considerable size. The second lateral saddle is very low and broad, and terminates near the umbilical suture. No auxiliary lobes.

In my specimen nearly two-thirds of the last whorl belong to the body-chamber.

Locality, number of specimens examined.—Zone of *Sibirites Prahlada*, Brachiopod-beds at the base of the Muschelkalk in the Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

Genus : ISCULITES, E. v. Mojsisovics.

In the Mediterranean triassic province the genus *Isculites* is only known from strata of upper triassic (carnic[1] and juvavic) age. Its occurrence in the Indian Mu-

[1] The terms Noric and Carnic have been used in this work in the sense attributed to them by Mojsisovics in the 2nd Volume of his work on the "Cephalopoden der Hallstaetter Kalke.

schelkalk is not beyond doubt. *Isculites Hauerinus*, Stoliczka, the only species of this genus from the Himálayan Trias, had been collected by Stoliczka near Lilang on the Lingti River in Spiti, but no satisfactory account is given of the exact horizon of the deposits in which these fossils were found. The only specimen under my observation, one of the two type-specimens of Stoliczka from the collection of the Geological Survey Museum in Calcutta, may, judging from the character of its matrix, as well belong to the Muschelkalk as to younger strata of upper-triassic age.

1. Isculites Hauerinus, Stoliczka. Pl. XXVII., fig. 3; Pl. XXXI, fig. 11.

1865. *Clydonites Hauerinus*, Stoliczka: Mem. Geol. Surv. of India Vol. V. Pt. I. Pl. IV. fig. 3, p. 50.

1886. *Isculites Hauerinus*, E. v. Mojsisovics: Arktische Trias-Faunen, Mem. de l'acad. impér. des sciences de St. Pétersbourg, VII ser. T. XXXIII. Nr. 6, p. 154.

1893. *Isculites Hauerinus*, E. v. Mojsisovics: Die Cephalopoden der Hallstætter Kalke II. p. 69.

Dimensions.

Diameter of the shell	29 mm.
Height of the last whorl	13 „
Thickness „ „ „ „	16 „
Diameter of the umbilicus	7 „

According to E. v. Mojsisovics, *Isculites subdecrescens*, v. Mojsisovics, (Die Cephalopoden der Hallstætter Kalke, II., 1893, Pl. LXXXVII. fig. 5, 6, p. 68) is the nearest ally to this form among the congeneric species of the Mediterranean Trias, both as regards general shape and the egression of the umbilicus. The sub-globose shell, laterally somewhat compressed, possesses greatly overlapping whorls. The aperture is broader than high; its greatest thickness coincides with the umbilical margin. The egression of the umbilicus begins near the inner extremity of the last whorl and gradually increases towards its outer extremity. The thickness of the whorl, meanwhile, considerably decreases, so much so that in the figured specimen, as in *Isculites subdecrescens* the last whorl is thicker near its beginning than near its termination. The rounded siphonal area is provided with a slight median groove in the inner whorls, which disappears on the body-chamber.

The surface of the only specimen, which I had the opportunity of examining, is much weathered. The thin lines of growth mentioned by Stoliczka are only visible near the siphonal groove. This specimen—it is the same that has been figured by Stoliczka (Pl. IV. fig. 3)—shows two radial furrows in the volution preceding the last whorl, whilst Stoliczka mentions the existence of three contractions in the shell.

Sutures.—Stoliczka's figure of the lobe-line (Pl. IV, fig. 3 b.) is taken from a second specimen, which unfortunately is not among the material sent from Calcutta and handed over to me for examination. In his notes on *Isculites Hauerinus*, E. v. Mojsisovics expressed some doubts as to the correctness of Stoliczka's drawing (reproduced in this memoir, Pl. XXVII. fig. 3 c.). In order to clear up this question I tried to take off the body-chamber of the specimen

before me, and I succeeded in preparing the lobe-line of the last septum. A comparison of my figure (Pl. XXXI. fig 11 b.) with Stoliczka's drawing clearly shows that in the latter the sutures are not only represented in a reversed position, but that also their flat, wavy, non-serrated outlines, given in Stoliczka's figure, are totally incorrect. It was in all probability a much weathered septum, which served as the original for Stoliczka's illustration.

Isculites Hauerinus, differs from all its congeneric species of the Mediterranean Trias by the possession of two auxiliary lobes. The principal lobes are strongly serrated. The indentations affect the marginal walls of the saddles up to their rounded extremities. As in *Isculites subdecrescens* and *Isculites Heimi*, v. Mojsisovics (l. c. Pl. LXXXVII. fig. 13, p. 67), the siphonal saddle is only serrated on its slope, towards the principle lateral lobe, whilst its marginal wall nearest the siphonal lobe remains entire. The three principal lobes and saddles are of nearly equal height.

The present specimen is distinguished by a long body-chamber, measuring one and a half circuits in circumference.

Locality, number of specimens examined.—Lilang, on the Lingti River (Spiti), 1, Coll. Geological Survey Museum in Calcutta (Stoliczka's type-specimen).

B. AMMONEA LEIOSTRACA.

Family : *PINNACOCERATIDÆ.*

Sub-family : PTYCHITINÆ.

Genus : MEEKOCERAS, Hyatt.

The genus Meekoceras, already very common in the lower Trias of the Himálayas, reaches the culminating point of its development in the Muschelkalk. Most of the Himálayan forms are closely allied to Mediterranean species of the group of *Meekoceras Reuttense*, Beyrich, but exhibit partly a more highly developed, brachyphyllic serration of their lobe-line (*Meekoceras Khanikofi*, Oppel, *Meekoceras Kesava*). One of the Himálayan species is identical with *Meekoceras affine*, v. Mojsisovics, from the Arctic-Pacific region of the Trias.

Meekoceras Rudra and *Meekoceras Gangadhara* may be considered to be isolated forms. The latter is distinguished by a very long, serrated umbilical lobe, whilst *Meekoceras Rudra* shows an arch-shaped arrangement of its sutural elements.

None of the Indian species of this genus possesses less than two auxiliary lobes at least.

1. Meekoceras Khanikofi, Oppel, Pl. VIII., fig. 8; Pl. IX., fig. 1, 2, 3, 9.

1863. *Ammonites Khanikofi*, Oppel: Palæontologische Mittheilungen I. p. 275, Pl. 76. fig. 4.
1865. *Ammonites Khanikofi*, Stoliczka: Memoirs Geol. Surv. of India, Vol. V, Pt. I, p. 52.
1866. *Ammonites Khanikofi*, Beyrich: Abhand. kgl. Akad. d. Wiss. Berlin, 1866, p. 146.
1882. *Meekoceras Khanikofi*, E. v. Mojsisovics: Cephalopoden der Mediterranen Triasprovinz, p. 216.

Dimensions.	I. (Oppel's type-specimen.)	II. (Pl. VIII. f. 8.)	III. (Pl. IX. f. 1.)	IV. (Pl. IX. f. 2.)	V. (Pl. IX. f. 3.)
Diameter of the shell .	68 mm.	62	100	69	76
Height of the last whorl	37	36	53	36	41
Thickness „ „ „ „	21	20	27	23	21
Diameter of the umbilicus	7	9	14	9	9

My collection contains a rich material of this Ammonite, which, together with *Ptychites rugifer*, Oppel, may be considered to be the most important leading fossil of the Indian Muschelkalk. The examination of it proves, that the typical form (Oppel's type-specimen and Pl. VIII. fig. 8), is subject to slight variations in the shape of its transverse section, the width of the umbilicus and the details of the sculpture. But it is only right to add, that the different varieties are connected by so many intermediate gradations, that there is no reason to separate them into several specific forms.

The typical form possesses a flat, discoidal shell, in its outlines very similar to that of *Meekoceras Reuttense*, Beyrich; a narrow, sharply rounded siphonal part, and a rather high, perpendicular, umbilical wall, separated from the sides by a rounded umbilical margin. The lateral parts slope very gradually towards the siphonal area. The transverse section is widest across the middle of the sides.

The proportion of the height and width of the aperture is not constant. Whereas in the typical form of *Meekoceras Khanikofi* the aperture is a little lower than in *Meekoceras Reuttense*, the proportion is quite different in other specimens (Pl. IX. fig. 1, 3, 9). In adult individuals especially the aperture, as a rule, is very high, as in a later stage of growth, the height of the whorls increases proportionately more rapidly than their width. In the mean time the volutions, which show egression[1], leave the spiral line, as it is clearly seen in the specimen figured Pl. IX. fig. 1.

The flanks are covered by numerous delicate falciform folds, closely situated, especially at an early stage of growth. These folds are always, even in very young specimens, less strongly developed on the lower portion of the sides, where they completely disappear in adult individuals. In young specimens the folds describe strongly curved segments with their convexity turned backwards on the upper portion of the flanks. They usually reach almost as far as the siphonal edge. In some specimens they are rather broad, in others thin and narrow and slightly elevated either near the siphonal margin or in the middle portion of the sides.

The number of folds in one volution differs considerably. It is 18 in Oppel's type-specimen, whereas in others it ranges from 14 to 20. In adult specimens the number of folds decreases. In the specimen Pl. IX. fig. 1, f. i. the outer volution bears only 14 or 15 folds.

[1] See foot-note on page 14.

In specimens, in which part of the shell is preserved, the surface distinctly shows very numerous thin lines of growth in the direction of the falciform folds. They are especially well marked near the umbilical margin (compare Pl. IX, fig. 1.).

Sutures.—E. v. Mojsisovics mentions *Meekoceras Khanikofi* among the congeneric species distinguished by three lateral lobes, but the examination of a very rich material has convinced me, that it possesses only two lateral lobes. In a very few specimens only, the projection of the spiral of the preceding volution touches the inner portion of the second lateral saddle; in most of them it affects the apex, in some even the outer portion of the second lateral saddle. In one specimen even, the position of the projection of the spiral of the preceding whorl in relation to the sutural line is not constant. However in none of our specimens have more than two lateral lobes been observed. Four auxiliary lobes and three auxiliary saddles follow outside the umbilical suture.

The lobes are deeply serrated at their base. The siphonal lobe, distinguished by the presence of deep, clearly individualised fingers, is placed on a nearly equal level with the second lateral lobe. The siphonal saddle is considerably lower than the principal lateral saddle and of the same height as the second lateral saddle. The brachyphyllic indentation of the suture likewise affects the arches of the elongated, proportionately narrow saddles. In some specimens there is a marked tendency to individualise the upper portion of the saddles, which is distinctly separated from the narrow lower portion by some deeper incisions, surrounded by finger-like processes. This tendency, which likewise occurs in some of the Alpine *Meekoceratidæ* as in *Meekoceras maturum*, v. Mojs. (l. c. Pl. L. fig. 3. p. 219), especially affects the siphonal and second lateral saddles (compare Pl. IX, fig. 3 b.) In a later stage of growth the brachyphyllic character of the sutures extends to the apices of the auxiliary saddles.

In some specimens I was able to observe the presence of a deep internal lobe.

In the specimen, figured Pl. IX. fig. 1, one of the largest in my collection, nearly one half of the last whorl belongs to the body-chamber.

Variety.—The specimen, figured Pl. IX. fig. 2, distinguished by its elliptical shape and the occurrence of lateral tubercles in the middle portion of the sides near the beginning of the outer strongly developed part of the falciform folds, I consider provisionally as a variety. In this specimen from the Schlagintweit collection, the lateral tubercles first appear, the anterior end of the last whorl reaching the height of 34mm. In none of the other specimens did I observe distinctly marked lateral tubercles, although in some of them slight elevations in the middle portion of the flanks may be noticed.

Locality, number of specimens examined.—Kuling, Spiti, 4, Coll. Schlagintweit (from the Palæontological State-Museum in Munich); 1, Coll. Geological Survey Museum in Calcutta; Muth, Spiti, 2, Coll. Geological Survey Museum in Calcutta; 1, Coll. Griesbach; Shangra (E. of Puling), Hundés. 2, Coll. Schlagintweit from the Palæontological Museum in Munich (among them Oppel's type-

specimen); Rimkin Paiar, E. G., 11, Coll. Diener; Tsang-Tsok-La, Hop Gádh, Hundés, 1, Coll. Griesbach; Bambanag cliffs (Girthi Valley), Jobár, 2, Coll. Diener.

Remarks.—The close relations, which exist between this species and *Meekoceras Reutlense*, Beyrich (Cephalopoden der Mediterranen Trias-provinz, Pl. IX. fig. 1, 2, 3, p. 215) have been clearly pointed out by E. v. Mojsisovics. There is indeed a great resemblance in general shape, involution and sculpture, although in the Indian form the number of folds on one circuit is usually a little greater. A more considerable difference consists in the arrangement of the sutures. *Meekoceras Reutlense* possesses three lateral lobes and only one auxiliary lobe outside the umbilical suture, which divides a bipartite auxiliary saddle. It also differs by its broader, less deeply serrated saddles.

2. Meekoceras Kesava, nov. sp. Pl. VIII. fig. 6.

Dimensions.

Diameter of the shell	51 mm.
Height of the last whorl	28 „
Thickness „ „ „ „	16 „
Diameter of the umbilicus	6 „

This form is very closely allied to *Meekoceras Khanikofi*, Oppel, but differs therefrom principally by its more slowly increasing whorls and a very narrow, deep umbilicus. A high perpendicular wall separates the latter from a sharply marked umbilical edge. The last volutions overlap so much, that the whole of the inner whorls are covered. No disjunction of the spiral line occurs. From the umbilical edge the flanks slope gradually in a very flat curve to the highly rounded siphonal part. The greatest thickness of the transverse section coincides with the lower portion of the sides.

The sculpture consists of numerous, very delicate falciform folds, which are but slightly curved and occur to the number of 20 in the last volution.

Sutures.—The arrangement of the lobe-line is similar to that in *Meekoceras Khanikofi*, but distinguished by a somewhat more highly developed brachyphyllic serration of the sutural elements. The tops of the high, elongated saddles are individualised by deep fingers which intersect the marginal walls and are strongly serrated. There are two lateral lobes as in *Meekoceras Khanikofi*. Two auxiliary lobes and as many saddles are situated outside the umbilical margin. It may therefore be assumed that yet another auxiliary lobe and saddle may be present between the umbilical margin and the umbilical suture.

Besides these, a very deep internal lobe has been observed in this specimen. The internal lobes of the different septa embrace each other in a funnel-shaped manner, as in a form of the *M. Hedenstroemi*-group, described by E. v. Mojsisovics.[1]

The present specimen is entirely chambered.

Locality, number of specimens examined :—Shalshal cliff, near Rimkin Paiar encamping ground; 1, Coll. Diener.

[1] Ueber einige arktische Trias Ammoniten des nördlichen Sibirien, Mém. de l'académie imp. des sciences de St. Pétersbourg, VII. sér. T. XXXVI. Nr. 5, 1888, p. 10.

3. Meekoceras proximum, Oppel Pl. VIII., fig. 2.

1865. *Ammonites proximus*, Oppel: Palæontologische Mittheilungen I. Pl. 83. fig. 1. p. 291.
1882. *Meekoceras proximum*, E. v Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz. p. 216.

Dimensions.

Diameter of the shell	51 mm.
Height of the last whorl	30 „
Thickness „ „ „ „	12 „
Diameter of the umbilicus	6 „

This species, of which only one single specimen (Oppel's) is at present known was fully described by Oppel and E. v. Mojsisovics. As I do not possess any new material for comparison, I may confine myself to repeating the diagnosis given by these eminent authors.

Concerning the general shape *Meekoceras proximum* differs from *Meekoceras Khanikofi* by its very high and peculiar transverse section. From the rather less steeply rounded siphonal part the flanks run almost parallel as far as the middle portion of the sides, but diverge here with a flat convexity, so much so, that the upper portion of the aperture appears to be considerably narrower than the lower part. The egression is more strongly marked than in *Meekoceras Khanikofi*, the umbilical suture leaving the spiral at a much earlier stage of growth. At the same time the steepness of the umbilical wall, sloping almost perpendicularly in the inner volutions, gradually diminishes as has been pointed out by Oppel. The sharply marked umbilical margin, however, remains unchanged and does not become rounded.

As in *Meekoceras Khanikofi*, the flanks are covered by falciform folds, marked distinctly only in the upper portion of the sides. These folds, to the number of 20 in the outer volution, increase in size proportionately to the stage of growth and in the middle portion of the sides develop into strong lateral tubercles; the last whorl reaching a height of 30mm. This sort of sculpture exactly recalls the sculpture of the specimen, figured pl. IX. fig. 2, which I consider to be a variety of the typical *Meekoceras Khanikofi*.

Sutures.—At a very early stage of growth the sutures are absolutely similar to those of *Meekoceras Khanikofi*. The lobes are deeply incised, the saddles narrow and elongated, with brachyphyllic margins, and serrated up to their very tops, which alone remain entire. At a more advanced stage our specimen, which is totally chambered, exhibits some remarkable differences. The anterior end of the last whorl reaches a height of 20mm., the saddles diminish in length but broaden considerably in other dimensions. Near the termination of the last whorl, the auxiliary saddles especially are much broader than high, no further progress in their serration being visible. There are only two lateral lobes, as in *Meekoceras Khanikofi*; the vertical projection of the spiral of the foregoing volution touches the inner portion of the second lateral saddle. The last whorl having reached the height of 30mm, the sutural line consists of four auxiliary lobes and three auxiliary saddles, besides the principal lobes and saddles. In the adult stage a fourth auxiliary saddle seems to appear.

The remarkably strong deposit of organic material near the tops of the saddles has already been observed by E. v. Mojsisovics when describing our specimen.

Locality, number of specimens examined.—Shangra (E. of Poling), Hundes, 1, Coll. Schlagintweit in the Palæontological Museum in Munich (Oppel's type-specimen).

4. Meekoceras Nalikanta, nov. sp. Pl. IX., fig. 5, 6, 7.

Dimensions.	I. (Pl. IX, fig 5.)	II. (Pl. IX. fig. 6.)	III. (Pl. IX. fig. 7.)
Diameter of the shell	36 mm.	39 mm.	40 mm.
Height of the last whorl	17 ,,	20 ,,	20 ,,
Thickness ,, ,, ,, ,,	9 ,,	10 ,,	11 ,,
Diameter of the umbilicus	9 7	7 ,,	8 ,,

Meekoceras Nalikanta is a small form, distinguished by a rather large umbilicus. In an early stage of growth, the whorls increase but slowly in height, but in later stages, however, the height of the last whorl increases more rapidly. In the specimen figured Pl. IX. fig. 5, f. i. the height of the aperture increases from 7 to 17mm. in the outer volution, of which more than one-third belongs to the body-chamber. As the thickness of the transverse section increases much more slowly, this form becomes very compressed in adult specimens, whereas in adolescent ones it is somewhat inflated. In the specimen figured Pl. IX. fig. 5, a thickness of 4mm. corresponds to a height of the last whorl of 4mm., 8mm. to a height of 10mm., 9mm. to a height of 17mm. Consequently a large full-grown specimen looks very different from the inner volutions.

The involution is rather small, the inner whorls overlapping each other only to the extent of two-thirds of their height.

The siphonal side is tolerably broad and rounded. The sides slope towards it in a very flat curve. The distance between them is greatest in the lower portion near the rounded umbilical edge. It is only in the body-chamber that the latter is well defined, and separated from the umbilical suture by a low umbilical wall. In the inner volutions the sides slope towards the umbilicus with a gradually increasing convexity, which is not interrupted by a clearly marked umbilical margin. So long as the aperture does not exceed 4mm. in height, the transverse section of the inner whorls is of an almost circular outline.

The surface of the sides is marked by *S*-shaped folds, of which there are about 20 in one circuit. At an early stage of growth, these folds are only visible on the lower portion of the sides, where they appear as slight convexities, which are turned forward. It is only in the body-chamber, that the folds also appear on the outer half of the sides, where their convexity is bent backwards rather more decidedly. Single and dichotomous folds are somewhat irregularly disposed. Frequently a faint one is intercalated between two stronger folds. Most of them increase in size, when approaching the siphonal margin, although not to any great extent.

Sutures.—The existence of only two lateral lobes may be concluded with certainty from the vertical projection of the periphery of the preceding volution to the septa of the last whorl near their lower parts. The lobes are provided with deep indentations, which affect the marginal walls of the narrow, elongated saddles up to the lower half of their height. The upper portion of the saddles remains entire. The position of the siphonal saddle is quite near the siphonal margin. The siphonal lobe does not reach half as high as the principal lateral lobe, which is situated very low. The deeply intersected, first auxiliary lobe, is followed by a bipartite auxiliary saddle, and a long umbilical lobe, consisting of different indentations, which in the last septa of the volution preceding the body-chamber divides into two distinct auxiliary lobes and saddles. The innermost of these auxiliary saddles is divided by the umbilical suture.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 2, Coll. Diener; Bambanag cliffs (Girthi valley), Johár 1, Coll. Diener.

5. Meekoceras Srikanta nov. sp. Pl. VIII, fig. 8, 9.

Dimensions.	I. (Pl. VIII, fig. 8.)	II. (Pl. VIII, fig. 9.)
Diameter of the shell	47 mm.	35 mm.
Height of the last whorl	26 „	19 „
Thickness „ „ „ „	14 „	10 „
Diameter of the umbilicus	6 „	5 „

This form bears a close resemblance to *Meekoceras Nalikanta*, from which it differs by greater involution, a more steeply rounded siphonal part, and folds which are almost radially arranged. The latter are only well developed on the middle portion of the sides, and are almost straight, but near the siphonal margin they describe a slightly falciform curve. In one of the specimens (Pl. VIII, fig. 8) 18 folds may be counted in the last volution, but no distinct bifurcations have been observed.

In the specimen fig. 9 nearly one half of the last whorl belongs to the body-chamber.

Sutures.—The sutural line is similar to that of *Meekoceras Nalikanta*. The saddles, however, are much broader and the principal lateral, compared to the siphonal lobe, is less deeply situated. There are two lateral and two auxiliary lobes. The second auxiliary lobe is divided by the umbilical suture.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar encamping ground, 2, Coll. Diener; Bambanag cliffs (Girthi valley), Johár, 1, Coll. Diener.

6. Meekoceras Narada, nov. sp. Pl. VIII, fig. 7.

Dimensions	
Diameter of the shell	51 mm.
Height of the last whorl	26 „
Thickness „ „ „ „	12 „
Diameter of the umbilicus	7 „

Like the foregoing, this species is very closely allied to *Meekoceras Nalikanta*, but differs therefrom by more slowly increasing volutions and a narrower, deeply sunk umbilicus. The only specimen of this form in my collection possesses an obliquely elliptical shape. As I have not more material at hand for comparison, I am unable to decide whether this is to be considered to be a constant specific feature, as seen in some species of the genus *Gymnites*, or as an accidental deformity. The latter does not seem probable to me, as all the other specimens, namely of *Meek. Khanikofi*, *Meek. Nalikanta* and *Meek. Srikanta*, were collected together with the individual in question and do not exhibit any trace of a similar deformity. In fact the fossils from the Muschelkalk of the Bambanag cliffs, where this specimen was found, are, as a rule, broken, but never deformed.

The sides are almost flat, and are separated from the umbilical suture by a perpendicular wall, which increases rapidly in the outer volution, and by a very sharp umbilical margin. The siphonal part is steeply rounded.

The sculpture consists of rather strong, broad folds, of which there are 20 in the last whorl. The folds are flexuous and describe an S-shaped curve, similar to those in *Meekoceras Nalikanta*. They are best developed near the middle part of the sides, and broaden out considerably in the body-chamber.

The shell is only partially preserved, but shows numerous thin radial striations which conform to the same direction as the folds.

In this specimen more than half of the outer volution forms part of the body-chamber.

Sutures.—Similar to those of *Meek. Nalikanta*, but they differ by a deeper position of the siphonal lobe, and slightly incised tops of the principal saddles. Three distinctly individualised, auxiliary lobes and an equal number of auxiliary saddles outside the umbilical suture. The second auxiliary lobe terminates in a single point and stands on a lower line than the first. The auxiliary saddles are quite entire.

Locality, number of specimens examined.—Bambanag cliffs, Girthi valley (Johár), 1, Coll. Diener.

7. Meekoceras affine, E. v. Mojsisovics, Pl. VIII, fig. 4, 5.

1886. *Meekoceras affine.*—E. v. Mojsisovics: Arktische Triasfaunen. Mém. de l'académie impér. des sciences de St. Pétersbourg sér. VII, T. XXXIII, No. 1, Pl. XI, fig. 17, p. 86.

Dimensions.	I. (Pl. VIII, fig. 4.)	II. (Pl. VIII, fig. 5.)
Diameter of the shell	31 mm.	24 mm.
Height of the last whorl	16 „	13·5 „
Thickness „ „ „	8·5 „	7 „
Diameter of the umbilicus	4 „	3·5 „

Both these specimens agree perfectly with *Meekoceras affine* from the Siberian Muschelkalk in shape, involution, sculpture and sutures.

The flat, discoidal shell is distinguished by its high aperture and narrow umbilicus. The sides are almost flat and pass gradually, but with quickly increasing convexity into the well-rounded siphonal part. The well-marked umbilical edge is separated from the umbilical suture by a perpendicular wall. In the larger of the two figured specimens, the umbilical edge becomes sharpened near the anterior termination of the last whorl, whilst it is obtuse in its posterior portion and in the inner volutions.

The sculpture consists of numerous, slightly curved, delicate folds, which broaden near the siphonal part, but become obsolete before they reach the siphonal margin. The surface of the folds is covered by very delicate striæ which run in the same direction. This striation is most distinctly seen in the preserved shell of the larger specimen (Pl. VIII, fig. 4), but is also visible in the cast.

In the larger specimen more than half, in the smaller one third, of the last volution belong to the body-chamber.

Sutures.—As has been pointed out by E. v. Mojsisovics, the lobe-line of *Meekoceras affine* is almost identical with that of *Hungarites triformis*, E. v. Mojsisovics, with the exception of the somewhat more minute incision of the auxiliary lobe and of the second lateral lobe. Our specimens agree perfectly with the description and figure of the sutures of *Hungarites triformis*, given by E. v. Mojsisovics (l. c. p. 88, Pl. XI. fig. 16). The deep siphonal lobe ends in three points and is situated very little higher than the principal lateral lobe. The latter is more deeply incised, and provided with seven points at its base. The second lateral lobe and the two auxiliary lobes are so faintly incised, that their serration is sometimes only visible by means of a magnifying glass. The second auxiliary lobe coincides with the umbilical margin. The saddles are rather elongated and lined by parallel marginal walls, their tops only being rounded into well-curved arches.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar encamping ground; 2, Coll. Diener.

8. Meekoceras Nanda, nov. sp. Pl. IX., fig. 8.

Dimensions.

Diameter of the shell	30·5 mm.
Height of the last whorl	14 „
Thickness „ „ „ „	8 „
Diameter of the umbilicus	5 „

This is the most graceful form among the Indian species of the genus *Meekoceras*. Its shell is rather less compressed that in *Meekoceras affine*, v. Mojs., from which it is further distinguished by slower increasing whorls, a greater width of the aperture, and a lesser involution. The siphonal part is narrow, well rounded, and sharply separated from the sides. Near the siphonal margin the latter are almost parallel to each other, as in *Meekoceras proximum*, Oppel, and only diverge near the middle portion of the shell, where they are slightly tumid. An obtuse

umbilical edge separates the flanks from a low but steep umbilical wall. The aperture reaches a height of 12 mm. and the umbilical suture shows considerable egression. This species differs from *Meekoceras affine* inasmuch as it shows a strongly marked tendency to disjunction of the spiral, in which respect it bears a close resemblance to *Meekoceras proximum.*

The sides exhibit a style of sculpture, which differs from that of any other Indian *Meekoceras.* They are covered with numerous rather strong folds or ribs which run in a straight, forward-directed line as far as the middle portion of the sides, and in the upper portion describe a falciform curve with its convexity turned backward. In the last volution about 25 ribs may be counted. Some of them bifurcate in the middle part of the sides, before becoming falciform, or may be said to divide into a stronger, principal rib and into a more faintly marked, secondary fold. The ribs reach their highest development near the point, where they change from a straight direction into a falciform curve. Here they swell out into elongated lateral tubercles or rather long drawn-out prominences, when the whorls have reached a height of 12 mm. The falciform portion of the ribs is, as a rule, less strongly developed than their lower, straight part. The ribs extend to the siphonal margin.

In the present specimen more than two-thirds of the outer volution belong to the body-chamber.

Sutures.—The sutural line is almost exactly identical with that of *Meekoceras affine*, v. Mojs., and *Hungarites triformis*, E. v. Mojs.*

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar encamping ground; 1 Coll. Diener.

ISOLATED FORMS.

9. Meekoceras Gangadhara, nov. sp. Pl. IX., fig. 4.

Dimensions.

Diameter of the shell	80 mm.
Height of the last whorl	42 „
Thickness „ „ „	19 „
Diameter of the umbilicus	8 „

The whorls increase so very slowly that they produce a small umbilicus, surrounded by a high, perpendicular umbilical wall. In the inner volutions the umbilical margin forms a sharp edge, whereas in the last volution it is somewhat rounded, and passes more gradually into the sides which are almost flat but curve gently towards the well-rounded siphonal part. The umbilical suture shows but very little egression when the whorls have reached a height of 45 mm.

In an early stage of growth the sculpture consists of flat, broad, falciform folds, of which 15 occur in one volution. In later stages—the whorl having reached a height of 30 mm—these folds bear delicate lateral prominences near the middle portion of the sides.

* *E. v. Mojsisovics*, Arktische Triasfaunen, l. c. p. 88, Pl. XI. fig. 16.

The extremely thin shell, which is but partially preserved in one of my specimens, is covered with numerous radial lines of growth which run in the same direction as the falciform folds.

Sutures.—In the figured specimen the existence of three lateral lobes has been proved with certainty from the vertical projection of the periphery of the last whorl but one, to the septa near the posterior termination of the body-chamber. The lobes are deeply incised. The elongated, narrow saddles are indented up to their very tops and possess brachyphyllic margins. The broad siphonal lobe is divided by a high siphonal tubercle. The third lateral lobe is followed by two auxiliary lobes, an equal number of saddles and a long, very remarkable umbilical lobe, the numerous denticulations of which slope obliquely towards the umbilical suture. It resembles closely the similar position of the auxiliary lobes in many species of the Triassic genera *Gymnites* and *Pinnacoceras*.

In our specimen more than two-thirds of the outer volution form part of the body-chamber.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar encamping ground; 2 Coll. Diener.

10. Meekoceras Rudra, nov. sp. Pl. X., fig. 1.

This species is represented by a rather fragmentary cast only, which does not permit of exact measurement.

In shape and sculpture it appears to be most closely allied to *Meekoceras Gangadhara*. The whorls increase very slowly, and apparently show little or no egression. The umbilicus is deep and surrounded by a steep umbilical wall. The transverse section seems to increase more rapidly in thickness than in *Meekoceras Gangadhara*. The siphonal part is narrow and steeply rounded.

As far as the weathered surface shows, the sides exhibit very indistinct, falciform folds, somewhat widely separated and confined to the outer portion of the sides. The surface of the body-chamber, to which one half of the last whorl belongs, bears well developed lateral tubercles near the middle portion of the sides.

Sutures.—The sutural line is characterised by a very peculiar, circular arrangement of its elements, which result in a low position of the siphonal lobe and in a bent direction of the auxiliary lobes. As the vertical projection of the spiral of the preceding whorl passes near the inner margin of the second lateral saddle of the next volution without touching it, our species must be placed among the forms with three lateral lobes. The extremely deep siphonal lobe is situated but very little higher than the principal lateral, and considerably lower than the second lateral lobe. The very low siphonal saddle is only half as high as the principal lateral one. The principal and second lateral saddles are of equal height, whereas the three lateral lobes are arranged in a semi-circular form. Three auxiliary lobes and an equal number of auxiliary saddles are outside the umbilical suture. The lobes are provided with long, finger-like indentations at their base, which affect likewise the marginal walls of the saddles. The tops of the latter seem to be but minutely incised.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar encamping ground; 1 Coll. Diener.

Genus: GYMNITES, E. v. Mojsisovics.

This genus is represented in the Muschelkalk of the Indian Triassic province by a considerable number of forms, which are more or less closely allied to Mediterranean types. Most of them have their nearest relations in the Alpine species of *Gymnites Humboldti* v. Mojs., *Gymnites incultus* Beyrich, and *Gymnites obliquus* v. Mojs.—*Gymnites acutus* v. Hauer from the Upper Muschelkalk of Han Bulog in Bosnia, apparently isolated up to now in the Mediterranean Trias, seems to be closely allied to the Himálayan *Gymnites Lamarki* Oppel. A very interesting group, entirely peculiar to the Indian Trias, which may perhaps justly claim a sub-generic rank, is constituted by *Gymnites* (*Buddhaites*) *Rama*, which in shape bears a remarkable resemblance to the Alpine genus *Carnites*.

1. Gymnites Jollyanus, Oppel. Pl. X., fig. 7.; Pl. XI., fig. 1.; Pl. XII., fig. 1.

1863. *Ammonites Jollyanus*, Oppel: Paläontologische Mittheilgn. I. Pl. 75, fig. 4, p. 271.
1865. *Ammonites Jollyanus*, Stoliczka: Memoirs Geol. Surv. of India, Vol. V, Pt. I, p. 51.
1882. *Gymnites Jollyanus*, E. v. Mojsisovics: Cephalopoden der Mediterranen Triasprovinz, p. 235.

Dimensions.	(Pl. X, fig. 7.)
Diameter of the shell	84 mm.
Height of the last whorl	39 „
Thickness „ „ „	14 „
Diameter of the umbilicus	21 „

As has been pointed out by E. v. Mojsisovics, among the congeneric forms of the European Muschelkalk, *Gymnites Humboldti* v. Mojsisovics[1] is the nearest ally to this remarkable species. Like *Gymnites Humboldti* the latter has narrow compressed, high, and rather involute whorls. The anterior end of the last whorl, however, is still considerably higher in *Gymnites Jollyanus*.

The sides are very flat and slope gently towards the umbilical suture, without forming an umbilical edge. The siphonal part is narrow and well rounded. The volutions increase but slowly and overlap each other to two-thirds of their height. The umbilical area is shallow and wide. The greatest thickness of the volutions coincides with the middle portion of the sides.

Adult specimens of this form attain very large dimensions. A totally chambered fragment from Rimkin Paiar, comprising one-half of a volution, corresponds with a diameter of 230 mm. and, including the body-chamber, the diameter of this individual cannot have been much less than 40 cm.

When the whorls of this species have reached a height of 20 mm., radial ribs begin to appear on the lower part of the sides. They are slightly bent backwards and are stronger developed near the middle part of the sides, where they form flat pro-

[1] l. c. Pl. LV, fig. 1—3, p. 235.

minences, interrupted by deep, rounded intervals. Sometimes they are so much shortened, that they appear only along a spiral line which divides the sides in the middle, formed by a chain of long drawn-out tubercles. When the whorls exceed 90 mm. in height, these spiral tubercles gradually become obsolete, but their upper end, formerly marked by a spiral line is still present, and forms a continuous ridge.

The body-chamber is wanting in all my specimens.

Sutures.—In the lobe-line of adult specimens an extraordinarily rich ramification of all sutural elements predominates. The vertical projection of the spiral line of the preceding volution meets the second lateral saddle close to the centre line of the latter, but inside of it. The siphonal lobe is somewhat shorter than the principal lateral lobe and is divided by a low and narrow siphonal tubercle. The siphonal saddle is lower than the principal lateral saddle and is situated at the same level as the second lateral saddle. It is characterised by the development of a broad, secondary, outer branch, which in itself is likewise richly ramified. The specimen figured Pl. X. fig. 7 has three auxiliary lobes and an equal number of auxiliary saddles. In larger specimens the number of auxiliary lobes amounts to four. The auxiliary saddles are bipartite.

Locality, number of specimens examined.—Kuling, Spiti, 2 Coll. Schlagintweit from the Palæontological Museum in Munich (among them Oppel's type-specimens); Muth, Spiti, 2, Coll. Stoliczka, from the Geological Museum in Calcutta; Shalshal cliff near Rimkin Paiar encamping ground, 5, Coll. Diener.

Remarks.—*Ammonites plano discus*, figured by Salter (Palæontology of Niti, Pl. 8, fig. 5, 6), which Stoliczka (l. c. p. 52) considers to be a young specimen of *Gymnites Jollyanus*, does probably belong to *Xenodiscus* or *Ophiceras*.

2. Gymnites Vasantasena, nov. sp. Pl. XIII., fig. 2.

Dimensions.

Diameter of the shell	79 mm.
Height of the last whorl	29 „
Thickness „ „ „	14 „
Diameter of the umbilicus	20 „

In its general shape and involution, this species, which is represented in my collection by a medium-sized entirely chambered specimen, is as closely allied to *Gymnites incultus* Beyrich[1] as *G. Jollyanus*, Oppel is to *G. Humboldti* v. Moja. It differs therefrom, however, by its slowly increasing volutions overlapping each other only to the extent of one-third of their height. The siphonal part is more steeply rounded and its transverse section rather cardiform; the greatest width of this whorl coincides with the lower third of the sides. The umbilical margin is rounded, and the low umbilical wall is less steeply inclined than in *G. incultus*.

The surface of the inner volutions is perfectly smooth. In the outer whorl radial ribs appear on the sides, when the whorl reaches a height of 18 mm. They are only

[1] E. von Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, p. 233, Pl. LIV, fig. 1—3.

visible on the lower portion of the sides and are most distinctly marked near the umbilical margin.

Sutures.—Similar to those of *Gymnites Jollyanus*, from which, however, they differ in some details. The shape of the principal lateral lobe furnishes a good characteristic of our species, as it divides near its base into two branches, which proceed from each side of the stem and terminate in long foliated portions, whereas the second lateral saddle terminates in one long branch with two equal branches on each side. Compared with the principal lateral lobe the second lateral lobe is situated considerably higher than in *G. Jollyanus*. The auxiliary lobes, also, are arranged along a more oblique line than in the latter species. Five auxiliary lobes in the last septa.

The vertical projection of the periphery of the preceding whorl touches the second lateral saddle in the next volution.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground; 1 Coll. Diener.

3. Gymnites Kirata, nov. sp. Pl. X., fig. 2, 3.

1865(?). *Ammonites Batteni*, Strachey: Palæontology of Niti, Pl. XI., fig. 2. (Provisional name without description of the fossil).

1866. *Ammonites Batteni*, Stoliczka, *ex parte*: Mem. Geol. Surv. of India, Vol. V., Pt. I., Pl. V., fig. 2., p. 60.

1867(?). *Ammonites Salteri*, Beyrich, *ex parte*: Ueber einige Cephalopoden aus dem Muschelkalk der Alpen, etc., Abhandlgn. Königl. Akad. d. Wissensch. Berlin, 1866. p. 134.

1882. *Gymnites nov. sp. ex. aff. G. Palmai*, E. v. Mojsisovics: Cephalopoden der Mediterranen Triasprovinz, p. 235.

Dimensions.	I. (Pl. X., fig. 2.)	II. (Pl. X., fig. 3).
Greatest diameter of the shell	63 mm.	21 mm.
" height of the last whorl	18·5 "	7·5 "
" thickness of the last whorl	14 "	5 "
" diameter of the umbilicus	40 "	9 "
Least height of the last whorl	16 "	6·5 "
" thickness of the last whorl	11 "	4 "
Corresponding diameter of the shell	57 "	16 "
" " of the umbilicus	32 "	6·5 "

Strachey assigned the name *Ammonites Batteni* to a fragment, figured in the Palæontology of Niti (Pl., XI. fig. 2), which Blanford placed erroneously among the Jurassic Cephalopoda of the Spiti-Shales, without mentioning it in the text of his work. Later on Stoliczka retained Strachey's provisional name for a species of *Gymnites* from the Muschelkalk of Spiti on the strength of Blanford's authority, who believed that it agreed well with Strachey's fragment, which Blanford himself had found much too imperfect, and had therefore omitted noticing it in his descriptions. However it had already been mentioned by Beyrich, that Stoliczka had united two very different forms under the name of *Ammonites Batteni*,—one of which Beyrich considered to be identical with *Ammonites incultus* from the Alpine Muschelkalk. E. v. Mojsisovics is of opinion that Stoliczka's variety of the *Ammonites Batteni*

with narrow and thick whorls (Pl. V., fig. 2) bears a closer relationship to *Gymnites Palmai*, E. v. Mojsisovics, whereas the second variety with high and compressed whorls (Pl. VI., fig. 1), is more closely allied to the European *Gymnites obliquus*, v. Mojs.

An examination of the material sent to Vienna from Calcutta has convinced me that even a third form had been identified by Stoliczka with *Ammonites Batteni*, a form which differs from the two above-mentioned species by possessing radial ribs on the lower portion of the sides. In consequence of the very imperfect state and figure of the fragment, which was provisionally named *Ammonites Batteni*, it is absolutely impossible to decide with which of the three species united by Stoliczka it may actually be identical. It only remains to introduce entirely new names for the latter, and to restrict the name of *Ammonites Batteni* to the fragment figured in the "Palæontology of Niti."

I give the name of *Gymnites Kirata* to Stoliczka's so-called variety of *Ammonites Batteni*, with narrow but thick whorls, which according to E. v. Mojsisovics has its nearest ally among the forms of the Alpine Muschelkalk, in *Gymnites Palmai*, v. Mojsisovics.[1]

Both these species agree in the outline of their transverse section. The whorls, however, increase much more slowly in the Indian form, and are more evolute, overlapping each other only to the extent of one quarter their height. The outline of this species is elliptical, as in *Gymnites obliquus*, v. Mojs.

Stoliczka has already laid some stress on the fact, that the elliptical shape common to all his specimens of *Gymnites Batteni* could not be an accidental deformity, as it was observed in specimens coming from three different localities. E. v. Mojsisovics likewise considers the oblique, elliptical shape not accidental, but characteristic of the species, as the specimens of the elliptically shaped *Gymnites obliquus* examined by him were imbedded in a matrix, in which the outlines of all the other fossils found with this species were perfectly normal. The same reasoning applies to the occurrence of the three elliptical species which were included in Stoliczka's *Ammonites Batteni*. In the Muschelkalk of the Bambanag cliffs (Girthi valley) I found an elliptically shaped specimen of *Gymnites Sankara* (the high compressed variety of Stoliczka's *Ammonites Batteni*), imbedded together with some specimens of *Meekoceras Khanikofi* and *Meekoceras Nalikanta*, which did not exhibit the least trace of deformity through pressure. It is equally remarkable that even very young forms, as for instance the specimens figured Pl. X, fig. 3, show the same elliptical outlines.

The oblique elliptical shape of the shell is the consequence of periodical deviations in the growth of the volutions, occurring always in the same parts of the different circuits. E. v. Mojsisovics tries to explain it, by assuming that in these species periods of an accelerated growth regularly alternate with periods of retardation.

The siphonal part is moderately convex. The sides slope in a gently

[1] Die Cephalopoden der Mediterranen Triasprovinz, p. 234, Taf. LVII, fig. 1, 2, Taf. LVIII.

rounded curve towards the very wide and shallow umbilical area. They are still perfectly smooth; the whorl reaches a height of 18 mm.

In neither of the specimens is the body-chamber preserved.

Sutures.—The sutural line is less richly ramified than in *Gymnites Jollyanus.* The very narrow pointed siphonal lobe is divided by a remarkably high siphonal tubercle. In the siphonal saddle the development of an outer secondary branch is but faintly marked. Four very steeply inclined auxiliary lobes outside the umbilical suture. The vertical projection of the outline of the preceding volution meets the inner margin of the deeply incised second lateral saddle in the succeeding whorl.

Locality, number of specimens examined.—Lilang, Spiti, 2 Coll. Stoliczka, from the Geological Museum in Calcutta.

4. Gymnites Salteri, Beyrich, Pl. XII., fig. 3.

1867. *Ammonites Salteri*, Beyrich: Ueber Einige Cephalopoden aus dem Muschelkalk der Alpen, Abhandlgn Königl. Akademie der Wissensch. Berlin 1866, Taf. III. fig. 2, p. 134.

A fragment in the collection of the missionary Prochnow was described by Beyrich under this name. It consists of two chambers and belongs to a species of *Gymnites* with rather high whorls. The shape of the transverse section recalls *Gymnites Kirata*. To a height of the whorl of 22 mm corresponds a width of 11 mm. On the lower portion of the sides indistinct traces of ribs are visible.

The lobe-line, which is but partially preserved, recalls *Gymnites Kirata*. The siphonal lobe is divided by a high siphonal tubercle. The siphonal saddle is provided with an outer secondary branch, which is less strongly individualised than in *Gymnites Jollyanus* or in *Gymnites Sankara.*

With this species Beyrich also identified the fragment, which was figured by Salter in his "Palæontology of Niti" (Pl. VI. fig. 3) and was erroneously compared by this author with *Ammonites neojurensis*, Quenst. or with *A. debilis*, v. Hauer. The sutures, however, do not sufficiently agree to justify this identification, as the lobe-line in Salter's fragment, if correctly represented in the figure, is distinguished by a remarkably large siphonal saddle without any outer secondary branch.

A more thorough comparison with *Gymnites Kirata*, a very close ally of this form, will only be possible on the ground of a richer and better preserved material. Nor can the question be decided whether *Gymnites Salteri* may be allowed to remain as a separate species.

Locality, number of examined specimens.—Ladakh (exact locality not known), 1 Coll. Prochnow, from the Museum für Naturkunde in Berlin.

5. Gymnites Sankara, nov. sp., Pl. XI., fig. 2.

1865.(?) *Ammonites sp. ind.* Salter : Palæontology of Niti, Pl. VI. fig. 3 p. 64.
1865.(?) *Ammonites Batteni*, Strachey : ibid. Pl. XI, fig. 2 (provisional name without description).
1865. *Ammonites Batteni*, Stoliczka, *ex parte* : Mem. Geol. Surv. of India, Vol. V, Pt. I, Pl. V. fig. 3 ; Pl. VI. fig. 1, p. 59.
1866. *Ammonites incultus*, Beyrich, *ex parte* : Ueber einige Cephalopoden aus dem Muschelkalk der Alpen etc., Abhandlgn. Königl. Akad. d. Wissensch. Berlin, 1866, p. 133.
1882. *Gymnites nov. sp. ex. aff. G. obliquus*, E. v. Mojsisovics : Cephalopoden der Mediterranen Triasprovinz, p. 237.

Dimensions.

Diameter of the shell	140 mm.
Greatest height of the last whorl	48 „
„ width of the last whorl	20 „
„ diameter of the umbilicus	58 „
Least height of the last whorl	30 „
„ width of the last whorl	19 „
Corresponding diameter of the shell	107 „
„ „ of the umbilicus	37 „

Gymnites Sankara agrees with the high, compressed variety of Stoliczka's *Ammonites Batteni*. Its relations to *Gymnites obliquus*, v. Mojs. from the Alpine Muschelkalk have been clearly pointed out by E. v. Mojsisovics. The elliptical outline is still more prominent in the Indian species, which is likewise distinguished by a higher and narrower whorl. The siphonal part is rounded. The sides are almost flat, and slope very gently towards the wide and shallow umbilicus. In none of my specimens have traces of ribs been observed.

This species differs from *Gymnites Kirata* by considerably greater involution and higher whorls. There are also some differences in the arrangement of the sutural line, especially in the shape of the siphonal lobe.

The body-chamber is wanting in my specimens.

Sutures.—The lobe-line bears a close resemblance to the sutures of *Gymnites incultus*, Beyrich. But the siphonal saddle is larger and characterised by the development of a broad, much ramified, outer branch, as in *Gymnites Jollyanus* or in *Gymnites* (*Buddhaites*) *Rama*. The siphonal lobe is but little shorter than the principal lateral lobe. Stoliczka's description of this species as being provided with a short siphonal lobe, is at variance with his figure (Mem., Vol. V, Pl. V, fig. 3), although this figure does not represent the relative size of the two lobes quite correctly. —Four auxiliary lobes, which are steeper inclined, than in *Gymnites incultus*. Especially the second of the bipartite auxiliary saddles is extensively denticulated.

Locality, number of specimens examined.—Lilang, Spiti, 1, Kuling, Spiti, 1, both from Stoliczka's collection in the Geological Museum in Calcutta ; Bambanag cliffs, Girthi valley, Johár, 1 Coll. Diener.

Remarks.—Beyrich[1] identified the high, compressed variety of Stoliczka's *Ammonites Batteni* with *Gymnites incultus*. This, however, does not seem justified considering the differences in shape of the whorls and the details of the sutural line.

The fragment figured by Salter may belong to *G. Sankara*, rather than to *G. Kirata*. In the outline of its section and in the siphonal lobe it agrees with *Gymnites Sankara*. In Salter's drawing the outer branch of the siphonal saddle is

[1] l. c. p. 133.

wanting, but in young specimens of *Gymnites Sankara* this is not so distinctly individualised as in later stages of growth.

6. GYMNITES, NOV. SP. EX. AFF. G. SANKARA, Pl. XIII., fig. 1; var. Pl. X., fig. 5.

1865. *Ammonites Batteni* Stoliczka, *ex parte*: Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 50.

Dimensions.

Diameter of the shell	150 mm.
Maximum height of the last whorl	60 „
„ width of the last whorl	30 „
Diameter of the umbilicus	50 „
Minimum height of the last whorl	43 „
„ width of the last whorl	23 „
Corresponding diameter of the shell	about 100 „
„ „ of the umbilicus	32 „

This species is very closely allied to *Gymnites Sankara*, but differs therefrom by rather more rapidly increasing whorls, a thicker transverse section, a less steeply rounded siphonal part and by the appearance of a row of lateral ribs in the lower portion of the sides, where the whorls reach a height of 25 mm. These very broad and flat ribs reach up to the middle part of the sides as in *Gymnites obliquus*, v. Mojs.[1] Our species bears a still nearer relationship to the latter than to *Gymnites Sankara*, but it differs in the sutures and possesses a more elliptical shape.

Sutures.—Very much like those of *Gymnites Sankara*, only somewhat broader and a little less ramified.

Locality, number of specimens examined.—Kuling, Spiti, 1 Coll. Stoliczka, from the Geological Museum in Calcutta; Shalshal cliff near Rimkin Paiar Encamping Ground, 1 Coll. Diener.

Remarks.—This species attains very remarkable dimensions. My specimen from Rimkin Paiar, which is unfortunately much injured, has a diameter of 340 mm, and the height of its last whorl is 147 mm. As it is entirely chambered, another three quarters of a volution must at least be reckoned for the body-chamber. Consequently the diameter of the adult individual could scarcely have been less than half a metre.

Variety.—I look upon a fragment from the Muschelkalk of the Utadhura in Johár as a variety of this species although it is distinguished by rather more rapidly increasing whorls, but it agrees perfectly in the details of the sutural line. The siphonal saddle shows a distinctly developed outer branch, where the whorl reaches a height of 6 mm. At the same time flat and broad radial folds begin to appear on the lower portion of the flanks. The body-chamber is wanting. The dimensions of this specimen, Pl. X, fig. 5, are as follows:—

Diameter of the shell	40 mm.
Maximum height of the last whorl	14 „
„ thickness of the last whorl	7·5 „
Diameter of the umbilicus	18 „
Minimum height of the last whorl	10 „
„ thickness of the last whorl	6 „
Corresponding diameter of the shell	27·5 „
„ „ of the umbilicus	11 „

[1] Die Cephalopoden der Mediterranen Triasprovinz, p. 236, Taf. LVI.

Another form, which is distinguished by smooth sides, is related to this species, with which it agrees in the shape of the whorls, but differs from *G. Sankara*. In my collection it is represented by the fragment of a body-chamber only, from the Shalshal cliff near Rimkin Paiar Encamping Ground.

7. Gymnites sp. ind. ex aff. G. Humboldti, v. Mojs., Pl. XII., fig. 2.

This is a fragment of a *Gymnites*, with high compressed whorls, which seems to be more closely allied to a species of the Alpine Muschelkalk than any of the Indian forms hitherto mentioned. In this fragment the height of the transverse section is 46 mm, the thickness about 20 mm. In the lower portion of the sides, traces of radial folds may be noticed.

The sutures seem to agree remarkably well with those of *Gymnites Humboldti* v. Mojs.[1] Especially the shape of the siphonal lobe and of the siphonal saddle are perfectly identical. The less rich ramification of the lateral saddles and of the but partly known, auxiliary saddles may be explained by the great weathering which this fragment has undergone.

Locality, number of specimens examined.—Bambanag cliffs, Girthi valley, Johár; 1 Coll. Diener.

8. Gymnites Lamarki, Oppel., Pl. X., fig. 6.

1863. *Ammonites Lamarki*. Oppel: Palæontologische Mittheilungen I, Taf. 76, fig. 3, p. 274.

1882. *Gymnites Lamarki*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz. p. 235.

Dimensions.	
Diameter of the shell	40 mm.
Height of the last whorl	17 „
Thickness of the „ „	13 „
Diameter of the umbilicus	12 „

This interesting form recalls in its general outlines and involution some species of the genus *Ptychites* (e. g. *Ptychites Malletianus*, Stoliczka); but the arrangement of the sutures impart to it the character of a true *Gymnites*, as has already been noticed by E. v. Mojsisovics.

Gymnites Lamarki has a slightly elliptical outline, slowly increasing volutions, which although overlapping each other considerably, leave a proportionately wide umbilicus. During the adolescent stage the involution is remarkably less pronounced than in later stages of growth. When the whorl reaches a height of 14 mm it overlaps the preceding one almost completely.

The sides are separated from the steep umbilical wall by a well-marked, somewhat rounded, umbilical edge. The greatest thickness of the transverse section coincides with the lower portion of the sides. The latter converge towards the sharpened siphonal part in the shape of a pointed arch, as in *Gymnites acutus*, describ-

[1] E. v. Mojsisovics, Die Cephalopoden der Mediterranen Triasprovinz, Taf. LV, fig. 1, p. 235.

ed by F. v. Hauer from the Muschelkalk of Bosnia.[1] Oppel suggested that in more perfectly preserved specimens the sharpened siphonal part might be provided with an elevated, prominent keel. In the figured specimen however, I cannot find any traces of such a keel, which might justify this suggestion.

In the anterior part of the outer volution a portion of the shell has been preserved, which shows indistinct traces of broad, flat folds. Similar traces may be observed also at different places on the cast. Part of the posterior end of the body-chamber is preserved.

Sutures.—The lobe-line shows the typical arrangement of the sutures peculiar to the genus *Gymnites*. Siphonal lobe broad, at almost as low a level as the principal lateral lobe. Siphonal saddle exceeds the principal lateral saddle in size. Second lateral saddle bipartite and deeply incised. Probably four auxiliary lobes outside the umbilical suture. Considering the small size of this specimen the sutural line is not very complicated.

Locality, number of specimens examined.—Kuling, Spiti, 1 Coll. Schlagintweit, from the Palæontological Museum in Munich (Oppel's type-specimen).

Remarks.—Among all the congeneric species of the European Muschelkalk, only the above-mentioned *Gymnites acutus* v. Hauer from Han Bulog in Bosnia bears some resemblance to our Indian form. The sharpened siphonal part, which is found in no other *Gymnites*, known up to now from the Alpine Muschelkalk, the thick whorl, the strongly curved convexity of the sides and the proportionately deep, stairlike umbilicus, are characters common to both species. *Gymnites Lamarki*, however, is still more involute and differs also considerably in the shape of the sutures.

I do not consider the sharpened siphonal part to be a character of sufficient importance to justify the establishment of a new sub-genus for these two forms, as has been suggested by F. v. Hauer. In closely allied species of the genus *Xenodiscus*, which may be considered to be the original form of *Gymnites*, similar differences in the shape of the siphonal part occur, without possessing the importance of sub-generic characters.

ISOLATED FORM.

(Sub-genus: BUDDHAITES, Diener.)

9. Gymnites (Buddhaites) Rama, nov. sp., Pl. XII, fig. 2; Pl. XIII., fig. 1. 2.

1865. *Ammonites floridus* Salter, *ex parte*: Palæontology of Niti, Pl. 6., fig. 1, p. 61.
1865. *Ammonites floridus* Stoliczka: Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 51.
1882. *Gymnites nov. sp.* E. v. Mojsisovics: Cephalopoden der Mediterranen Triasprovinz, p. 227.

Dimensions.	I. (Pl. XIV, fig. 1.)	II. (Pl. XIV, fig. 2.)
Diameter of the shell	150 mm.	98 mm.
Height of the last whorl	90 „	56 „
Thickness of the „ „	32 „	17 „
Diameter of the umbilicus	9 „	8·5 „

[1] Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien I. Denkschr. Kais. Akademie d. Wissensch. i. Wien, 1892, Bd. LIX, Taf. X, fig. 6, Taf. XI, fig. 2, p. 282.

This species, one of the most important leading fossils of the Himálayan Muschelkalk, is at an early stage of growth, just as in *Gymnites Jollyanus* Oppel, characterised by narrow, high, slowly increasing volutions and a rounded siphonal part. When the whorl attains a height of more than 8 mm., the involution and general shape of the shell changes in a very remarkable manner. The volutions overlap each other to two-thirds of their height so closely, that at a diameter of 30 mm the outer whorl covers the preceding one and the diameter of the umbilicus does not increase any more. Instead of a wide and shallow umbilicus, which is an important character in *Gymnites Jollyanus*, our species exhibits at later stages of growth a narrow, deep umbilicus, surrounded by a high, partially overhanging umbilical wall. The deep umbilicus, exposing only the innermost volutions in adult specimens, is separated from the flat sides by a rounded umbilical margin. Together with the stronger involution, the siphonal part becomes narrower and perfectly sharpened,—the whorl reaching a height of 20 mm. This sharpening of the siphonal part to a knife-like edge persists also in later stages and exhibits a very characteristic difference from *Gymnites Jollyanus*.

In this manner *Gymnites Rama* actually acquires in the adult stage a great external similarity with *Carnites floridus* Wulf. with which species it has often been confounded by former authors. But its sutures always retain the typical arrangement of the *Gymnites* lobe-line, although the shape of the shell considerably approaches that of the genus *Carnites* or *Pinnacoceras*. The stages of development are also entirely different in *G. Rama* and *Carnites floridus*, the latter passing from the *Meekoceras*-stage through the *Hungarites*-stage into the *Carnites*-stage.

Gymnites Rama develops ribs of the same size as does *Gymnites Jollyanus*. Only at an early stage of growth these ribs are confined to the middle portion of the sides; later they gradually pass across it. They are, however, not developed in the shape of straight, radial prominences, but form slightly falciform elevations, arranged along a spiral line, which gradually passes from the middle part into the upper portion of the sides. In very large specimens this spiral line appears as a continuous ridge in the outer whorl.

All the specimens figured in this memoir are entirely chambered. But there are a few fragments of body-chambers in my collection; the largest of these fragments shows a height of the last whorl of more than 120 mm.

Sutures.—The arrangement of the sutural line resembles that of *Gymnites Jollyanus* Oppel, although there are differences noticeable when comparing specimens of equal height of whorls. The siphonal saddle is much broader, and its outer secondary branch still further individualised. In this respect the sutures approach the arrangement of the lobe-line in *Carnites floridus*, in which this individualisation of the outer secondary branch has developed into a proper adventitious saddle.

The inclination of the auxiliary lobes is less steep than in *Gymnites Jollyanus*. The richly ramified, second lateral saddle is provided with a broad, inner secondary branch. Five auxiliary lobes outside the umbilical suture. Auxiliary saddles with

several incisions. The vertical projection of the outline of a whorl meets the apex of the second lateral saddle in the succeeding volution.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1 Coll. Griesbach; 5 Coll. Diener; Silakank-Pass, Painkandha, 1 Coll. Griesbach; East slope of Marchauk Pass, near Barahoti Encamping Ground, Hundes, 1 Coll. Griesbach; Lilang, Spiti, 1 Coll. Stoliczka, from the Geological Survey Museum in Calcutta; North of Kalapani, Kali River Valley, Byans, 4 Coll. Griesbach.

Remarks.—*Gymnites Rama* has been mistaken for *Carnites floridus* Wulf. by Suess, Salter and Stoliczka. Beyrich[1] already proved this identification to be erroneous and compared our species to a *Gymnites* described by F. v. Hauer. According to E. v. Mojsisovics the specimens, described by Salter as *Ammonites floridus*, belong to two different genera, *Gymnites* and *Hungarites*. His figure[2] corresponds to a specimen of *Gymnites Rama*. To this form are likewise to be added all the ammonites, identified with *Carnites floridus* by Stoliczka and Griesbach.[3]

In the genus *Gymnites* the present species represents a distinct group, differing so considerably from the rest of the congeneric forms, that it may properly be considered to be the type of a special sub-genus. As sub-generic characters are to be mentioned the gradual changes in the shape of the umbilical area and of the siphonal part in proportion to the progressing growth of the individual. For this sub-genus I propose the name of *Buddhaites*. The question whether close affinities actually do exist between this new sub-genus and *Carnites*, which is completely isolated in the fauna of the Alpine Triassic province, I must leave undecided.

Genus : STURIA, E. v. Mojsisovics.

Sturia Sansovinii, E. v. Mojsisovics. Pl. XV.

1882. *Sturia Sansovinii* E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst. Vol. X. Taf. XLIX. fig. 5, 6, 7. Taf. L. fig. 1, p 241.
1887. *Sturia Sansovinii* F. v. Hauer: Die Cephalopoden des bosnischen Muschelkalkes von Han Bulog bei Sarajevo, Denkschr. Kais. Akad. D. Wissensch. Wien. Bd. LIV. p. 46.
1892. *Sturia Sansovinii* F. v. Hauer: Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien ibidem Band LIX. Taf. X, fig. 7. p. 283.

Dimensions.

Diameter of the shell	247 mm.
Height of the last whorl	148 „
Thickness of the „ „	65 „
Diameter of the umbilicus	4 „

This species, peculiar to the zone of *Ceratites trinodosus* in the Alpine Muschelkalk is represented in the Himálayan collection by a specimen, which perfectly and in every respect agrees with the description and figure given by E. v. Mojsisovics.

[1] Abhandlgn. Königl. Akad. d. Wissensch. Berlin, 1866, p. 46.
[2] Palæontology of Niti, Pl. VI. fig. 1.
[3] Geology of the Central Himálayas, Mem. Geol. Surv. of India, Vol. XXIII, 1891.

In the shape of its transverse section this specimen corresponds to the sub-lenticular form figured by that eminent author in his Pl. XLIX, fig. 5. The sides are rather strongly curved, the greatest thickness of the whorl still coincides with the lower portion of the lateral parts. A rounded umbilical margin separates the umbilical wall, which becomes perpendicular in the outer volutions, and encloses the very narrow, almost completely closed umbilicus. The siphonal side is much compressed and highly rounded.

The sculpture of the shell exhibits the typical spiral striations which are arranged in three different groups as it were. In the siphonal part and near the siphonal margin the striations are narrow, sharply edged and separated from each other by interstices of only 1 mm distance. In this section they are consequently very numerous, thin and arranged close to each other. In the upper portion of the sides they are a little broader, flat and but slightly prominent, separated by interstices of 1½ to 2 mm in distance. In the lower portion of the lateral parts they are, on the contrary, strongly developed and elevated. There the spiral striations and the intervening furrows are of equal size, being about 2 mm each in width. A strong contrast is noticeable therefore between the very broad and stout striations near the umbilical margin, and the thinner, less prominent striations on the upper portion of the sides. In our specimen this character is not less remarkable than in E. v. Mojsisovics' type-specimen from the Mediterranean Trias.

On the lower portion of the sides the furrows between some of the stout spiral striations are partly divided by very thin thread-like spiral lines, such as have been observed by F. v. Hauer in some individuals of this species from the Bosnian Muschelkalk.

The spiral striations are not confined to the shell, but are also marked on the surface of the cast.

Sutures.—Are absolutely identical with the lobe-line of the species figured by E. v. Mojsisovics (Pl. XLIX, fig. 7), as may be seen from a comparison with our figure. Proportionately to the greater size of our specimen, there are seven auxiliary lobes, corresponding to a height of the last whorl of 105 mm (whereas there are six in the type-specimen of E. v. Mojsisovics, corresponding to a whorl of 80 mm). The bifid termination of the principal lateral lobe is a good specific character.

Our specimen is entirely chambered.

As I could not detect any characters in which this species differs from *Sturia Sansovinii*, I am compelled to identify it with the latter. This determination has been confirmed by Dr. E. v. Mojsisovics, who kindly examined my Himálayan specimen, and likewise thinks it to be identical with the Alpine form.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1 Coll. Diener.

Genus: PTYCHITES, v. Mojsisovics.

Among the five sections, into which the forms belonging to the genus *Ptychites*, from the Alpine Muschelkalk, may be divided, only one, the group of the *P.*

subflexuosi, has not yet been discovered in the Indian Triassic province, whereas representatives of the *P. rugiferi, megalodisci, opulenti* and *flexuosi* are abundant.

The group of the *Ptychites rugiferi* predominates, and some of its forms belong to the most common fossil types, as for instance, *P. rugifer*, Oppel. This species and its nearest ally, *P. tibetanus*, v. Mojsisovics, show close relationship to some Spitzbergen forms. Another species of this group, *P. cognatus*, Oppel, may be compared to the European *P. Stachei*, v. Mojsisovics. The rest of the species belonging to the section of the *Rugiferi* are new. Among them *P. Mangala*, *P. Asura* and *P. Sukra* are more closely allied to the Indian *P. rugifer*, than to any Mediterranean forms, whereas *P. Govinda* may be considered an isolated type.

The group of the *Ptychites megalodisci* is represented by three species. Two of them, *P. impletus*, Oppel, and *P. Sahadeva*, bear some affinities to *P. Pauli*, v. Mojsisovics. The third, *P. Sumitra*, differs but in very subordinate details from the Alpine *P. megalodiscus*, Beyrich.

The group of the *Ptychites opulenti* has three representatives in the Indian Trias, all allied to the Alpine species *P. opulentus*, v. Mojs., and *P. progressus*, v. Mojs. Of the two forms, which must be placed in the group of the *P. flexuosi*, *P. cochleatus*, Oppel, may be compared with *P. Studeri*, v. Hauer, whereas *P. Mahendra* is a close relation of *P. flexuosus*, v. Mojs., from the Mediterranean Muschelkalk.

Besides these groups, two additional sections may be distinguished among the Himálayan *Ptychites*, which have not been discovered up to now either in the Mediterranean or in the Arctic-Pacific province, but must be considered as faunistic elements peculiar to the Indian Trias.

One of these groups, which I propose to call *Ptychites orbilobi*, has two lateral lobes and is distinguished by the semi-circular arrangement of the laterally forward-curved sutures, which remind me of the lobe-line in *Cyclolobus*, Waagen, or in *Joannites*, E. v. Mojsisovics. *Ptychites Gerardi*, Blanford, ought to be taken as a type of this group.

The second of these groups is represented by *P. Malletianus*, Stoliczka, and its relations. The species of this section are provided with two lateral lobes and differ especially by their numerous low volutions, which do not overlap each other much, and the extraordinarily wide umbilicus. This character in which they differ from the typical forms of the genus *Ptychites* is so important, that Beyrich[1] thought himself justified in placing *Ammonites Malletianus* among the group of *Gymnites incultus*. The arrangement of the sutures, however, imparts to this ammonite the character of a true *Ptychites* and clearly establishes its generic position.

Among the 18 species, which are described in the following section of this Memoir, 7 belong to the group of the *P. rugiferi*, 3 to the group of the *P. megalodisci*, an equal number to that of the *P. opulenti*, 2 to the group of the *P. flexuosi*, one to the group of the *P. orbilobi*, 2 to the group of the *P. Malletiani*.

[1] Ueber einige Cephalopoden aus dem Muschelkalk der Alpen, etc., Abhandlgn. Königl. Akademie d. Wissensch. Berlin, 1866, p 134.

a. Group of the PTYCHITES RUGIFERI.

1. Ptychites rugifer, Oppel., Pl. XXII, fig. 1, 2; Pl. XXIII, fig. 1, 2; Pl. XXIV, fig. 1, 2.

2. Ptychites tibetanus, E. v. Mojsisovics. Pl. XXIV, fig. 3.

1865. *Ammonites rugifer*, Oppel: Palaeontolog. Mitthlgn. I. Taf. 85, figs. 2, 3, p. 293.

1865. *Ammonites Studeri*, v. Hauer, *ex parte*: Die Cephalopoden der unteren Trias der Alpen, Sitzgsber. Kais. Akad. d. Wissensch. Wien, Math. Nat. Classe Bd. LII., p. 629, 639.

1865. *Ammonites Gerardi*, Stoliczka, *ex parte*: Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 54.

1867. *Ammonites Gerardi*, Beyrich, *ex parte*: Ueber einige Cephalopoden aus dem Muschelkalk der Alpen, etc Abhandlgn. Königl. Akad. d. Wissensch. Berlin, 1866, p. 125.

1882. *Ptychites rugifer*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abhandl. kk. Geol. Reichsanst. Vol. X, p. 247.

1886. *Ptychites Tibetanus*, E. v. Mojsisovics, Arktische Triasfaunen, Mém. Acad. des sciences de St. Pétersbourg VII. sér. T. XXXIII. No. 6, Taf. XIV, fig. 5, p. 96.

Dimensions.	I. (Pl. XXII, fig. 2)[1]	II.[2]
Diameter of the shell	93 mm.	86 mm.
Height of the last whorl	46 „	40 „
Thickness „ „ „ „	51 „	58 „
Diameter of the umbilicus	15 „	12·5 „

Oppel's type-specimen of *Ptychites rugifer* is of a more globose shape than any form of the group of the *P. rugiferi* from the Alpine Muschelkalk. It has a broadly rounded siphonal area, and a rather wide umbilicus, surrounded by a steep umbilical wall. In young specimens this umbilical wall is, as a rule, less steeply inclined than in adult ones. The sharply defined, somewhat obtuse umbilical margin, which in later stages of growth becomes slightly rounded, marks the region, where the whorl attains the maximum of its thickness. In the last volution, 17 proportionately strong folds or ribs are noticeable. They begin somewhat outside the umbilical margin and are considerably broader when approaching the siphonal area, which most of them cross in the shape of flat swellings. Some of them, however, are arranged asymmetrically on both sides of the siphonal part.

The type-specimen of *Ptychites tibetanus*, E. v. Mojsisovics, differs from Oppel's type-specimen of *P. rugifer* by its still more globose shape, greater thickness of the last whorl and a considerably larger number of radial ribs (25). But the sutural line agrees perfectly in the two forms.

My examination of a very rich material has convinced me, that the differences between the two forms are not very prominent. The greater number of radial ribs is certainly not peculiar to the typical *P. tibetanus*. The same remark applies to the proportions in the last whorl of *P. rugifer*, which are so various, that even *P. tibetanus* might justly be regarded as a mere variety of extraordinary thickness.

In the following list the measurements in a series of specimens are grouped

[1] Oppel's type-specimen of P. rugifer.

[2] E. v. Mojsisovics' type-specimen of P. tibetanus.

together, showing the amount of variation in the dimensions of the last whorl and in the number of ribs:—

	Diameter of the shell	Height of the last whorl	Thickness of the last whorl		Number of radial ribs
I.[1] (Pl. XXII, fig. 2)	98 mm.	46	51	+5	17
II.	120 mm.	61	63	+2	18
III.	109 mm.	53	56	+3	18
IV. (Pl. XXIII, fig. 1.)	118 mm.	60	63	+3	13 (to the last half volution.)
V.	76 mm.	37	46	+9	12 (to the last half volution.)
VI. (Pl. XXIII, fig. 2.)	93 mm.	47	55	+8	23
VII. (Pl. XXII, fig. 1.)	123 mm.	59	58	−1	18
VIII.	106 mm.	50	48	−2	13 (to the last half volution.)
IX.	97 mm.	46	45	−1	21
X. (Pl. XXIV, fig. 2.)	70 mm.	37	45	+8	17
XI. (Pl. XXIV, fig. 1.)[2]	70 mm.	37	48	+11	19
XII. (Pl. XXIV, fig. 3.)[3]	86 mm.	40	58	+18	5

This list shows clearly that the number of radial ribs is as large in *P. Tibetanus* as in forms with a still higher whorl than that in Oppel's type-specimen of *P. rugifer*. The number of ribs cannot therefore be accepted as decisively characteristic of one of the two forms. Concerning the proportions of their transverse sections, the specimens grouped in the present list, with the exception of No. XII, are connected by so many links, that apparently they do not contain two distinct species, but must all be identified with Oppel's *P. rugifer*. Within this species merely more or less globose varieties may be distinguished, as in *P. flexuosus*, the last whorl of which also varies considerably in thickness.[1]

The type specimen of *P. Tibetanus* differs, however, in the proportion of height and thickness of the outer volution so remarkably from all the rest of the *Rugiferi* that for the present it may be looked upon as a distinct species. But in this case the term *P. Tibetanus* ought only to be applied to extremely globose forms, in which a similar abnormal proportion in height and thickness of the last whorl prevails.

Sutures.—The very short and narrow siphonal lobe is divided by a low siphonal tubercle. From the principal lateral lobe the lobe-line rises obliquely to the umbilical margin. The lateral and auxiliary lobes are divided at their base, each by two converging points. The siphonal saddle is richly ornamented and provided with a distinctly individualised foliaceous branch which is situated at the upper portion of the saddle, near the junction with the principal lateral lobe. At the opposite side to this

[1] Oppel's type-specimen.
[2] Identified by E. v. Mojsisovics with *P. tibetanus*.
[3] The type-specimen of E. v. Mojsisovics.

branch corresponds a similar one, near the base of the principal lateral saddle. This individualisation of two foliaceous branches, on both sides of the principal lateral lobe, takes place, however, only in advanced stages of growth. The saddles are asymmetrical. The top of the second lateral saddle is deeply incised. The first auxiliary saddle is bipartite, the second coincides with the umbilical margin. One more auxiliary lobe and saddle follow outside the umbilical suture.

Locality, number of specimens examined.—*α Ptychites rugifer.*—Kuling, Spiti, 3 Coll. Schlagintweit, from the Palæontological Museum in Munich (among them Oppel's type-specimen); Spiti, 2 Coll. Schlagintweit, in the Museum für Naturkunde in Berlin; S. E. of Muth, Spiti, 3, Coll. Griesbach, Geological Survey Museum in Calcutta; Lilang, Spiti, 1, Coll. Geological Survey Museum in Calcutta; Shalshal cliff near Rimkin Paiar encamping ground, 18 Coll. Diener.

β Ptychites Tibetanus.—Spiti, 1 Coll. Schlagintweit, from the Palæontological Museum in Munich (E. v. Mojsisovics' type-specimen).

Remarks.—E. v. Mojsisovics has already pointed out the close relationship of *Ptychites Tibetanus* to some species of the *Rugiferi* group, from the Daonella-limestone of Spitzbergen, especially to *P. latifrons*, v. Mojs., and to *P. Nordenskjoeldi*, v. Mojs. The Indian species is more closely allied to *Ptychites Nordenskjoeldi* in the arrangement of the sutural line than to any other form of this group. In the Spitzbergen species[1] the sutures are, however, more richly ornamented, the lateral branches of the saddles being bordered by deep indentations, which enter so deeply, that only the interior stem is left entire. Another difference is in the first auxiliary saddle, which is bipartite in the Indian species.

Among the congeneric forms of the Mediterranean Muschelkalk none is closely allied to *P. rugifer* or to *P. Tibetanus*, although *P. eusomus*, Beyrich, bears some resemblance to the first in its general shape.

8. Ptychites Mangala, nov. sp., Pl. XXVII., fig. 1.,

Dimensions.

Diameter of the shell	97 mm.
Height of the last whorl	49 „
Thickness of the „ „	42 „
Diameter of the umbilicus	16 „

This species is very closely allied to *P. rugifer*, Oppel, but differs from it in a less globose shape, a more shallow umbilicus, surrounded by an obliquely inclined wall, and in details of the sutural line. The siphonal part is considerably narrower than in *P. rugifer* and steeply rounded. The greatest thickness of the last whorl coincides with the rounded umbilical margin. From the latter the umbilical wall slopes obliquely towards the proportionately wide umbilicus, whereas in individuals of *P. rugifer* of an equal stage of growth it is almost perpendicular.

This specimen has 21 radial folds in the last volution. They rise close outside the umbilical margin and disappear near the siphonal part, which remains perfectly smooth.

[1] E. v. Mojsisovics, Arktische Triasfaunen, l. c. Taf. XIII, fig. 3, p. 93.

Sutures.—The sutural line of this species agrees generally with that of *P. rugifer.* The principal difference consists in the shape of the first auxiliary saddle, being entire in *P. Mangala*, whereas in *P. rugifer* it is bipartite.

In the figured specimen a little more than one quarter of the last volution belongs to the body-chamber.

Locality, number of specimens examined.—Spiti (locality not precisely known), 1 Coll. Schlagintweit, from the Palæontological Museum in Munich.

4. Ptychites Sukra, nov. sp., Pl. XXVII., fig. 2.

Dimensions.

Diameter of the shell	67 mm.
Height of the last whorl	34 „
Thickness of the „ „	20 „
Diameter of the umbilicus	11 „

In this species the whorls are still more compressed than in *P. Mangala.* Its general shape and sculpture remind one somewhat of the well-known *P. Studeri*, v. Hauer, which, however, has three lateral lobes.

From the rounded umbilical margin, which coincides with the region of the maximum thickness, the sides slope with moderate convexity towards the highly rounded siphonal part. The stair-like umbilicus is surrounded by a steeply inclined umbilical wall.

There are 18 folds or ribs in the last whorl of the figured specimen; they are curved backwards near the siphonal margin, as in the true *P. Studeri, v.* Hauer.[1] They rise near the umbilical margin and become obsolete in the siphonal part, but some few cross it in the shape of very indistinct prominences.

Sutures.—In consequence of the unfavourable state of the matrix, I have not succeeded in tracing the sutural line in all its details. So far as I am able to judge it seems to agree with the lobe-line of *P. rugifer* Oppel. The first auxiliary saddle is bipartite.

Three quarters of the last volution belong to the body-chamber.

Locality, number of specimens examined.—Spiti (locality not known exactly) 1 Coll. Schlagintweit, from the Palæontological Museum in Munich.

5. Ptychites cognatus, Oppel, Pl. XVIII., fig. 5, 6.

1868. *Ammonites cognatus*, Oppel : Palæontolog. Mittheilgn. I Taf. 81, f. 3, Taf. 85, fig. 4, p. 285.
1865. *Ammonites Gerardi*, Stoliczka *ex parte* : Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 54.
1882. *Ptychites cognatus*, E. v. Mojsisovics : Die Cephalopoden der Mediterranen Triasprovinz, Abh. k. k. Geol. Reichsanst., Vol. X, p. 247.

Dimensions.	I. (Pl. XVIII, f. 5.)	II. (Pl. XVIII, f. 6.)
Diameter of the shell	59 mm.	61 mm.
Height of the last whorl	35 „	33 „
Thickness of the „ „	40 „	35 „
Diameter of the umbilicus	9 „	7 „

[1] *E. v. Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz, Abhandlungen kk. Geol. Reichsanstalt. Vol. X, Taf. LXIII, fig. 1, p. 260.

Ptychites cognatus has been erroneously identified with *P. Gerardi*, Blanf., by Blanford and Stoliczka, but it is more closely allied to *P. Stachei*, v. Mojs.,[1] as has been stated by E. v. Mojsisovics. It differs from the Alpine form by its more globose shape, the thickness of its last whorl and its narrow umbilicus, whereas sculpture and sutures are very similar in the two species.

Most of the specimens, which I have examined, were more or less deformed and crushed, so much so, that a correct idea of the shape of the shell cannot be formed from the measurements alone. The slowly increasing globose volutions are thickest around the slightly rounded umbilical margin. A high and perpendicular umbilical wall separates the latter from the umbilical suture. The involution of the whorls takes place exactly outside the umbilical margin. The very narrow and deep umbilicus is one of the most remarkable features of this species and permits of an easy distinction from *P. rugifer*, which for the rest bears a great external resemblance to *P. cognatus*. The siphonal area is broadly rounded.

The numerous, straight, radial folds rise close outside the umbilical margin and become obsolete, when approaching the siphonal area, which remains perfectly smooth. The number of radial folds in the last volution of my specimens is from 20 to 23.

All my specimens are entirely chambered.

Sutures.—The vertical projection of the outline of the penultimate volution meets the apex of the second lateral saddle.

The sutural line resembles that of *P. Stachei*, v. Mojs., but differs by its two lateral lobes which are provided with two converging points rising from their base. The ornamentation of the saddles does not affect the stems so deeply as in *P. rugifer* and in *P. Tibetanus*. The lobes are placed at an equal level. The short, narrow, siphonal saddle is provided with a low siphonal tubercle. The first auxiliary saddle is deeply incised and bipartite. The second auxiliary saddle coincides with the umbilical margin. Two more auxiliary lobes and an equal number of saddles follow outside the umbilical suture.

Locality, number of specimens examined.—Kuling, Spiti, 4 Coll. Schlagintweit, from the Palæontological Museum in Munich; Spiti (locality not exactly known), 4 Coll. Geological Survey Museum in Calcutta; Spiti and Shángra (Hundés), 2 Coll. Schlagintweit, from the Museum für Naturkunde in Berlin.

6. Ptychites Asura, nov. sp., Pl. XXVII., fig. 5.

1865. *Ammonites Ausseanus*, Stoliczka, *ex parte*: Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 53.

Dimensions.

Diameter of the shell	33 mm.
Height of the last whorl	16 „
Thickness of the „ „	20 „
Diameter of the umbilicus	5(?)„

The generic relations of a globose ammonite, which Stoliczka erroneously identified with *Ammonites Ausseanus*, have been elucidated by an examination of

[1] Die Cephalopoden der Mediterranen Triasprovinz, l. cit. Taf. LXII. fig. 3, p. 247.

the sutures, which I succeeded in tracing out by splitting off a part of the shell. Our specimen evidently belongs to the genus *Ptychites* and must be regarded as an extremely globose representative of the *Rugiferi*-group. Its general shape actually recalls *Arcestes*, excepting in the umbilical region, which, to judge from its rather fragmentary state of preservation, seems to agree with that of *P. rugifer*, Oppel.

The shell is entirely smooth, without trace of folds or furrows.

The last third of the outer volution belongs already to the body-chamber.

Sutures.—Resembling the sutures in *P. rugifer* at an equal stage of growth. But the siphonal saddle is distinguished by its abnormally small size and all the lobes are placed on the same level. Three auxiliary lobes outside the umbilical suture.

Locality, number of specimens examined.—Lilang, Spiti, 1 Coll. Stoliczka; from the Geological Survey Museum in Calcutta.

7. PTYCHITES GOVINDA, nov. sp., Pl. XXI., fig. a, b, c.

Dimensions.

Diameter of the shell	196 mm.
Height of the last whorl	92 „
Thickness of the „ „	83 „
Diameter of the umbilicus	62 „

This beautiful species is distinguished by its rapidly increasing whorls, a highly rounded siphonal part, and a wide, funnel-shaped umbilicus. The inner wall of the umbilicus is obliquely inclined, at an angle of about 45 degrees, as in *P. cochleatus*, Oppel. The involution takes place exactly at the umbilical margin. Nothing is therefore exposed of the inner volutions, except their umbilical edge, which is visible inside the umbilicus in the shape of a screw-like spiral line.

The greatest thickness of the last whorl coincides with the umbilical margin. From this the sides converge towards the narrow siphonal part with a moderate convexity. In the inner volutions the umbilical margin forms a sharply marked obtuse edge, which becomes somewhat rounded in the last whorl.

The sides are covered with broad, radial folds which rise outside the umbilical margin and become obsolete in the siphonal area. There are 22 of them on the last volution.

In spite of its remarkable size the figured specimen is entirely chambered. The partly preserved shell is 2·5 mm. in thickness and exhibits a layer, wrinkled in the direction of the radial folds.

Sutures.—Whereas in *P. rugifer* and its allies the sutural line is characterised by an oblique arrangement of the lobes, rising from the principal lateral lobe, which is the deepest towards the umbilical margin, in *P. Govinda* the two lateral lobes are placed at the same level and the sutural line is deepest in the first auxiliary lobe, which is richly serrated and enlarged at its base. Siphonal lobe very short, terminating in a deep point. The second lateral and the first auxiliary saddle are highly foliaceous, especially so on the stems, which are rather deeply incised. From

the inner margin of the second lateral saddle rises a highly foliaceous and well-individualised secondary branch, as in the group of *P. Malletianus*, Stoliczka. The second auxiliary lobe is situated at the umbilical margin. Between this and the umbilical suture there is a second, branched, auxiliary saddle and two more auxiliary lobes, interrupted by a short saddle.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1 Coll. Diener; East Slope of Tsang-Tsok-La, Hop gadh, (Hundés), 1 Coll. Griesbach, from the Geological Survey Museum in Calcutta.

β. Group of the PTYCHITES MEGALODISCI.

8. (1) PTYCHITES IMPLETUS, Oppel, Pl. XVIII, fig. 4

1865. *Ammonites impletus*, Oppel: Palæontologische Mittblgn. I. Taf. 85, fig. 5, p. 294.
1882. *Ptychites impletus*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst., Vol. X, p. 251.

Dimensions (of the inner volutions).

Diameter of the shell	47 mm.
Height of the last whorl	15 „
Thickness of the „ „	30 „
Diameter of the umbilicus	18 „

Oppel's type-specimen is an entirely chambered, much crushed cast; it was compared by E. v. Mojsisovics with the European *P. Pauli* v. Mojs., but it is considerably thicker than any of the Alpine forms of this group.

The figured fragment (Oppel's type-specimen) is of a very globose shape, the thickness of the last whorl being twice as great as the height. It has a proportionately wide umbilicus, by which it is easily distinguished from the Indian *Ptychites* of the "*Opulenti*" group, which it resembles somewhat in general shape. The inner wall of the umbilicus is high and steeply inclined; the umbilical margin forms a distinctly marked edge. The greatest thickness of the last whorl coincides with the latter. From the umbilical margin the sides slope gently to the siphonal part, which is rounded into the shape of a pointed arch. The volutions overlap as far as the umbilical margin.

No folds or ribs have been noticed on the sides; the last whorl attains a height of 20 mm.

Sutures.—The sutural line is not completely known, but seems to agree in general with the sutures of *P. Pauli*, v. Mojs.[1] The siphonal lobe is short, but the siphonal saddle only very little less high than the principal lateral saddle. The second lateral saddle is bipartite and deeply incised. The second auxiliary lobe coincides with the umbilical margin. The saddles and lobes are highly foliaceous and their lateral branches much more strongly developed than in *P. Pauli*.

Locality, number of specimens examined.—Kuling, Spiti, 1 Coll. Schlagintweit, from the Palæontological Museum in Munich.

[1] Cephalopoden der Mediterranen Triasprovinz, Taf. LXII, fig. 2, p. 251.

9. (2) Ptychites Sahadeva, nov. sp., Pl. XXV., fig. 1, 2.

Dimensions.	I. (fig. 1.)	II. (fig. 2.)
Diameter of the shell	113 mm.	48 mm.
Height of the last whorl	69 „	21 „
Thickness of the „ „	51 „	25 „
Diameter of the umbilicus	21 „	10 „

The young individuals of this species closely resemble *Ptychites Pauli*, E.v. Mojsisovics,[1] and *P. impletus*, Oppel, in general shape and involution. But whereas these two species are distinguished through persistence of the adolescent character in later stages of growth, in *P. Sahadeva* the volutions become more compressed and higher in the adult stage. This change is clearly seen in the figured specimens, but it is still more remarkable in larger ones. In my largest specimen the diameter of the shell is 220 mm, the outer whorl 118 mm in height and only 68 mm in thickness. The difference of shape in adult and in young individuals is rather considerable.

In spite of the change which the proportions of the last whorl undergo, *P. Sahadeva* is more closely allied to the two above-mentioned species, than to any of the flatter discoidal forms of the group of the "*Megalodisci*," the flattening of the volution not being combined with a contraction of the umbilicus.

The deep umbilicus is surrounded by a steeply inclined inner wall, separated from the sides by a sharp umbilical margin. The sides converge almost without convexity towards the siphonal part, which is slightly sharpened in young individuals, but becomes slightly rounded in later stages of growth. The involution takes place quite close to the umbilical margin, but in very large specimens the outer volution exhibits egression and apparently leaves the spiral line.

In the specimen figured Pl. XXV, fig. 1, the last whorl shows 15 flat, straight folds, which pass across the siphonal part in the shape of wavy, flexuous elevations. In young specimens the surface of the shell is almost smooth, exhibiting faint grooves near the umbilical edge only, which correspond to the depressions between the different folds. These grooves gradually die out when approaching the siphonal part.

The elliptical outline of this specimen is probably not a specific character, but is an accidental deformity due to crushing. All the fossils which come from this locality, as *Ceratites Kuvera*, *Gymnites* (*Buddhaites*) *Rama*, *Nautilus Griesbachi*, are deformed and crushed in a similar manner.

In the largest of my specimens, with a diameter of 220 mm, three fourths of the outer volution form part of the body-chamber.

Sutures.—Similar to those of *P. Pauli*, v. Mojs., but the lateral branches of the saddles are further developed. The principal lateral saddle especially is provided with individualised and richly foliaceous secondary branches. The siphonal saddle is considerably shorter than the principal lateral one. The second lateral and the

[1] Cephalopoden der Mediterranen Triasprovinz Abh. Geol. Reichsanst., Vol. X, Taf. LXII, fig. 2, p. 251.

first auxiliary saddles are deeply incised above, bipartite, and provided with narrow stems at their base. The second auxiliary lobe is divided by the umbilical edge. Two bipartite auxiliary saddles follow outside the umbilical suture. Siphonal lobe short, with a high siphonal tubercle.

The rest of the lobes are each divided at their base by two converging points, giving them a trifid termination.

Siphuncle.—In the ventral area of the specimen figured Pl. XXV, fig. 1, the narrow siphuncle, consisting of anastomosing fibres, is partly exposed.

Locality, number of specimens examined.—North of Kalapani, Kali River Valley (Byans), 7. Coll. Griesbach (Geological Survey Museum in Calcutta).

10. (3) PTYCHITES SUMITRA, nov. sp., Pl. XXVI.

Dimensions.

Diameter of the shell	260 mm.
Height of the outer whorl	142 „
Thickness of the „ „	80 „
Diameter of the umbilicus	6 „

The present species, one of the largest of the "*Megalodisci*" group, is very closely allied to *P. megalodiscus*, Beyrich,[1] from which it only differs by its more broadly rounded siphonal part, by a rounded umbilical margin, and in some details of the sutural line. The umbilicus is narrow, funnel-shaped and surrounded by a steep inner wall, distinctly defined by a rounded umbilical margin, whereas in *P. megalodiscus* the umbilical margin retains a sharp edge even at later stages of growth. The siphonal part is highly rounded but never sharpened. The whorls are rather less compressed than in *P. megalodiscus*, the outer whorl being proportionately lower. For the rest, the outlines and the involution of the shell agree perfectly in the two species.

The shell, which is but partially preserved, is smooth, exhibiting only very thin and indistinct lines of growth. The cast is entirely smooth.

The body-chamber occupies three-fourths of the last volution. The margin of the aperture is partly preserved. It forms a deep lateral depression in the lower portion of the shell, which is followed by a flat lappet turned forward. In the outer portion of the shell a second slight depression marks the beginning of a rather narrow siphonal process. This process is partly broken off in this specimen. To this projecting ventral process a contraction of the shell in the siphonal part corresponds, encircling its topmost portion. There is a considerable similarity with the mouth borders of *P. eusomus*, Beyr., and of *P. acutus*, E. v. Mojs.[2]

Sutures.—Very much like those of *P. megalodiscus*, but differing in the shape of the saddles, which have broader and stronger stems. The siphonal saddle especially is less richly ornamented. The siphonal lobe is at a somewhat higher level

[1] E. Beyrich, Ueber einige Cephalopoden aus dem Muschelkalk der Alpen, etc., Abhandlgn. Kgl. Akad. d. Wiss. Berlin, 1866. Taf. II., p. 135; E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz Abh. Geol. Reichsanst. Vol. X, Taf. LXXVII, fig. 1, Taf. LXXVIII. f. 1, 2, p. 253.

[2] l. c. Taf. LXIX, LXVI, fig. 6 *a*.

than in *P. megalodiscus*. Siphonal tubercle large, pyramidal, and strongly serrated Siphonal saddle lower than the principal lateral saddle. Second lateral and auxiliary saddles bipartite. Number of auxiliary lobes 5 (as in Beyrich's type-specimen of *P. megalodiscus* from Reutte), corresponding to a height of the outer whorl of 80 mm. A comparison with the figure of the sutural line given by Beyrich, shows clearly the greater progress in the ornamentation of the siphonal and of the principal lateral saddles in the European species.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

γ. Group of PTYCHITES MALLETIANUS.

11. (1) Ptychites Malletianus Stoliczka, Pl. XVII., fig. 1.

1865. *Ammonites Malletianus* Stoliczka : Mem. Geol. Surv. of India Vol. V. Pt. I.—Pl. 5, fig. 1, p. 58.

Dimensions.

Diameter of the shell	108 mm.
Height of the outer whorl	39 „
Thickness „ „ „ „	43 „
Diameter of the umbilicus	43 „

This interesting species differs from all congeneric forms hitherto known, by its numerous, low, slowly increasing whorls, which, however, do not overlap to any great extent, and by its extraordinarily wide umbilicus. The volutions overlap each other to the extent of a little more than one-third of their height, the greater part of them being therefore exposed within the umbilical area. The maximum thickness of the volutions coincides with the sharp umbilical margin, from which a high perpendicular wall slopes down to the umbilical suture. The sides are moderately convex, the siphonal side is rounded.

This specimen,—Stoliczka's type,— has 26 to 28 flatly convex folds within the last volution, which are arranged close to each other and rise only at some distance from the umbilical margin. They are radially directed and disappear, as they approach the siphonal margin; they broaden out and flatten gradually, but without becoming flexuous.

The specimen is entirely chambered.

Sutures.—The sutural line is characterised by a remarkably reduced size of the auxiliary saddles and the development of a strongly individualised secondary branch rising from the inner margin of the second lateral saddle. Two lateral lobes. Siphonal lobe short, siphonal saddle nearly as high as the second lateral saddle. Lobes and saddles richly ornamented. First auxiliary saddle very short and tripartite, like the second, which is considerably broader. The second auxiliary lobe coincides with the umbilical margin. Two auxiliary lobes outside the umbilical suture. Third auxiliary saddle entire.

Locality, number of specimens examined.—Lilang, Spiti, 1, Coll. Stoliczka, Geological Survey Museum in Calcutta (Stoliczka's type-specimen).

Remarks.—No allied forms of *P. Malletianus* have hitherto been discovered. Like *P. Gerardi* it represents an isolated type peculiar to the Indian Trias.

12. (2) Ptychites nov. sp. ind.

Ex. aff. Pt. Malletiano. (Pl. XVII., fig. 2.)

This is a form, related to *P. Malletianus* Stol., which is likewise distinguished by low, not much overlapping volutions and a wide umbilical area. The only specimen available is unfortunately fragmentary. To a diameter of the shell of 54 mm corresponds a diameter of the umbilicus of 23 mm. The thickness of the transverse section is considerably greater than in *P. Malletianus*. The sides pass gradually into the broadly rounded, siphonal area. A high, perpendicular, umbilical wall separates the obtusely rounded umbilical edge from the umbilical suture.

The sculpture consists of folds or ribs, better defined than in *P. Malletianus*. There are nine of them on the outer volution and they rise close to the umbilical margin. Approaching the siphonal margin, they become less prominent but broaden out gradually. They do not completely disappear in passing across the siphonal area.

As this entirely chambered specimen is much deformed, I have not been able to take exact measurements. As to its dimensions I must therefore refer to the figure.

Sutures.—Similar to those of *P. Malletianus*, but the inner secondary branch of the second lateral saddle is still more strongly developed. Only one auxiliary lobe outside the umbilical margin. The latter coincides with the short but richly ornamented first auxiliary saddle. The second deeply incised auxiliary saddle is higher than the first one. Three auxiliary lobes between the umbilical margin and the umbilical suture.

Locality, number of specimens examined.—North of Padam, Spiti, 1, Coll. Geological Survey Museum in Calcutta.

8. Group of the PTYCHITES ORBILOBI.

13. (1) Ptychites Gerardi Blanford Pl. XVIII. fig. 1, 2, 3; Pl. XXV., fig. 3.

1863. *Ammonites Gerardi*, Blanford: Journal Asiatic Soc. of Bengal, XXII. p. 132, Pl. II. fig. 6.
1865(?). *Ammonites Gaytani* Salter: Palæontology of Niti, Pl. 7, fig. 7, 8, p. 65.
1865. *Ammonites Gerardi*, Stoliczka. *ex parte*: Mem. Geol. Surv. of India, Vol. V. Pt. I. p. 54.
1882. *Ptychites Gerardi*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst. Vol. X. p. 247.

Dimensions.	I. (Pl. XVIII. f. 1.)	II. (Pl. XVIII. f. 2.)	III. (Pl. XVIII. f. 3.)[1]
Diameter of the shell	67 mm	56 mm.	51 mm.
Height of the outer whorl	36 „	30 „	26·5 „
Thickness „ „ „ „	32 „	31 „	28 „
Diameter of the umbilicus	8 „	7 „	8 „

This often-mentioned species has been repeatedly confounded with several

[1] Blanford's type specimen.

other forms of the "*Rugiferi*" group, which occur in the same horizon, although Blanford has already given a sufficiently good description of his type-specimen and has clearly pointed out the peculiar shape of the—rather badly figured—sutural line. Oppel is therefore perfectly right in not identifying a single form among the *Ptychitidæ*, collected by the brothers Schlagintweit with the true *Ptychites Gerardi*, and E. v. Mojsisovics justly remarks in opposition to Beyrich[1] "that among the rich material of Indian triassic ammonites in the Schlagintweit collection not one single specimen is met with, which agrees with the description and figure of *Ptychites Gerardi*, Blanford." As I have sufficient material of this species at hand, partly from Stoliczka's, partly from my own collections, besides Blanford's type-specimen, its diagnosis presents no difficulty.

The typical form of *Ptychites Gerardi* is distinguished by an almost triangular shape of the section of its outer whorl; the sides slope from the umbilical margin, where they are most distant, towards the narrow but rounded siphonal area, with tolerably even convexity. Young individuals are of a more globose shape and provided with a broadly rounded siphonal part (Pl. XXV. fig. 3). The higher the form grows in later stages, the more sharpened becomes the siphonal part and the more characteristically appears the peculiar shape of the section of the outer whorl, recalling some *Ptychites* of the "*Megalodisci*"-group, which Blanford justly designates as "trigona." The clearly defined umbilical margin is but slightly rounded. The umbilical wall is steep. The width of the umbilicus varies considerably. In one of my specimens from Rimkin Paiar the diameter of the umbilicus is 14 mm, corresponding to a diameter of the shell of 68mm. In another specimen from the same locality the diameter of the shell is 80 mm the diameter of the umbilicus only 10 mm. The involution does not take place exactly at the umbilical margin, but parts of the inner volutions are exposed in the stair-like umbilicus, recalling *P. Studeri* v. Hauer.

At an early stage of growth the shell is perfectly smooth. When the outer whorl reaches a height of 25 mm, very flat, radial folds are noticed, covered with numerous thin and delicate striations, corresponding to growth-lines. They rise outside the umbilical margin and broaden out considerably towards the siphonal part. In the specimen figured Pl. XVIII. fig. 1, nine to ten of these radial folds may be counted in the last half volution. The sculpture is always much more delicate than in *P. cognatus* or in *P. rugifer*, which have sometimes been mistaken for this species.

Sutures.—Differ from all the rest of the congeneric species hitherto known by their semi-circular arrangement, their convexity being laterally curved forward. The vertical projection of the outline of the penultimate volution meets the inner margin of the second lateral saddle. Consequently *P. Gerardi* must be placed among the forms with two lateral lobes. The siphonal lobe is very short and narrow and provided with a high siphonal tubercle. The lateral lobes end with elongated terminal points with lateral digitations symmetrically arranged on each side. The second lateral and the first auxiliary saddles are of nearly equal size and

[1] Abhandlgn. Koenigl. Akademie d. Wissensch. Berlin. 1866, p. 125.

provided with two terminal lateral branches. Four auxiliary lobes outside the umbilical suture. The second and third auxiliary saddles are also bipartite. A fourth auxiliary saddle is divided by the umbilical suture, when the outer whorl reaches a height of 20 mm.

Locality, number of specimens examined.—Spiti Valley, 3, coll. Asiatic Society of Bengal (among them Blanford's type-specimen); Shalshal Cliff near Rimkin Paiar Encamping Ground, 4, coll. Diener; Bambanag Cliffs, Girthi Valley, Johár, 1, coll. Diener.

Remarks.—In a later memoir Blanford erroneously identified *P. Gerardi* with *P. cognatus* Oppel,[1] a view which was accepted by Stoliczka. *P. cognatus* belongs, however, to the group of *P. Stachei*, v. Mojs., as was pointed out by E. v. Mojsisovics, and may be easily distinguished from this species by its broadly rounded siphonal part and the absolutely different arrangement of the lobe-line. Beyrich went still further in uniting not only all the different species of Himálayan *Ptychites*, established by Oppel, but even some forms from the European Muschelkalk in one single species, which he called *Ammonites Gerardi*.

The two ammonites figured by Salter[2] as *Ammonites Gaylani* are probably young specimens of *P. Gerardi*, judging from the arrangement and shape of their sutures.

No allied form of *P. Gerardi* has hitherto been discovered, neither among the Mediterranean, nor among the Indian congeneric species.

ε. Group of the PTYCHITES OPULENTI.

14. (1) Ptychites Everesti, Oppel. Pl. XIX. fig. 1; Pl. XX., fig. 1, 6.

1863. *Ammonites Everesti*, Oppel: Palæontolog. Mitthlgn. I. Taf. 81, fig. 1, 2, p. 284.
1865. *Ammonites Everesti*, v. Hauer: Die Cephalopoden der unteren Trias der Alpen. Sitzgsber. Kais. Akad. d. Wissensch. Wien, Math. Nat. Cl. LII. Bd. p. 639.
1867. *Ammonites Gerardi*, Beyrich, *ex parte*: Ueber einige Cephalopoden aus dem Muschelkalk der Alpen, etc. Abhandlgn. Koenigl. Akad. d. Wiss. Berlin 1866. p. 126.
1882. *Ptychites Everesti*, E. v. Mojsisovics: Cephalopoden der Mediterranen Triasprovinz. Abh. k.k. Geol. Reichsanst. Vol. X. p. 260.

Dimensions.	I. (Pl. XIX. f. 1)	II. (Pl. XX. f. 2).
Diameter of the shell	168 mm.	63 mm.
Height of the outer whorl	75 "	32 "
Thickness " " " "	85 "	41 "
Diameter of the umbilicus	37 "	12 "

This form is closely allied to the European representatives of the "*Opulenti*" group from the Alpine Muschelkalk, but differs in the sculpture of its shell and the acutely rounded siphonal part.

[1] Oppel's type-specimen. [2] Palæontology of Niti, p. 106. [3] Ibid. Pl. 7, fig. 7, 8.

The section of the outer whorl is almost triangular, similar to that of *P. Gerardi*, but the latter has considerably higher and more compressed whorls. The maximum thickness of the whorls coincides with the umbilical margin, from which the slightly convex sides converge towards the acutely rounded siphonal part, which in young individuals is sometimes even sharpened. In *P. Gerardi*, as I have mentioned before, just the opposite development takes place, the siphonal part being rounded at an early stage of growth, but becoming sharper in adult individuals.

The deep umbilicus is bordered by a steep inner wall. The steepness increases in proportion to the stage of growth. In very large specimens (Pl. XIX. fig. 1) the umbilical wall is quite perpendicular in the last whorl, whereas it is steeply inclined in the inner volutions. The involution takes place exactly at the umbilical margin, the inner volutions being only defined inside the umbilicus by a screw-shaped, spiral line. In young specimens the umbilical margin is, as a rule, more definitely rounded than at later stages of growth. In large specimens it is always sharper although never edged.

F. v. Hauer describes the sculpture of the shell as consisting of radial grooves or furrows, which rising close outside the umbilical margin are indeed a much more characteristic element of its sculpture than the interstices between them. But even the latter are more or less of the shape of folds or ribs, and more so, than in any of the *Ptychites* of the "*Opulenti*"-group from the Alpine Muschelkalk. In Oppel's type-specimen the number of folds, in the last volution, is 11, whereas it is 14 in the specimen from Rimkin Paiar, figured in Pl. XIX., corresponding to a diameter of the shell of 168 mm. The broad, deep grooves disappear near the siphonal part, differing in this respect from the European *P. opulentus*, v. Mojs.[1] and *P. progressus*, v. Mojs.,[2] in which they pass across the siphonal part. The intervals between the grooves, corresponding to folds, are proportionately narrower near the umbilical margin, but broaden out considerably towards the siphonal margin.

The shell, as far as preserved, is covered with numerous wrinkly striations, which, though somewhat wavy, run generally parallel to the folds.

Sutures.—In *P. Everesti* the peculiar shape and arrangement of the sutures in the group of the *P. opulenti* is well exemplified. The principal lateral lobe is divided at its base by a large central point, causing it to terminate in two equal-sized digitations. The remaining lobes end in single terminal, with corresponding lateral, digitations, being each divided at their base by two large, converging points. The tops of the saddles are bipartite, the saddles themselves being shaped symmetrically.

From the sutures of *P. progressus*, which E. v. Mojsisovics believes to be most closely allied to our form among all the species of the Mediterranean Muschelkalk, the lobe-line of *P. Everesti* differs especially by a higher siphonal

[1] Abh. k.k. Geol. Reichsanst. Pl. LXXIII, fig. 1, 2, 3, 4, p. 259.
[2] l. c. pl. LXVII, fig. 4, 6, p. 259.

saddle. The siphonal lobe is very short and narrow. The vertical projection of the outline of the penultimate whorl meets the third lateral lobe in the outer volution. Third lateral saddle bipartite, and terminates in two symmetrical branches. One auxiliary lobe and saddle outside the umbilical margin.

Locality, number of specimens examined.—Shangra, E. of Poling, Hundés, 2, Coll. Schlagintweit, from the Palæontological Museum in Munich (among them Oppel's type-specimen); Shalshal cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener; Spiti, 1, Coll. Schlagintweit from the Palæontological Museum in Munich.

15. (2) Ptychites Vidura nov. sp. Pl. XX., fig. 2, 3, 4, 5.

1882. *Ptychites nov. sp. ex aff. Pt. Everesti*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz. Abh. k.k. Geol. Reichsanst. Vol. X. p. 260.

Dimensions.	I. (Pl. XX. f. 4.)	II. (Pl. XX. f. 3.)
Diameter of the shell	60 mm.	66 mm.
Height of the outer whorl	25 ,,	34 ,,
Thickness ,, ,, ,, ,,	26 ,,	31 ,,
Diameter of the umbilicus	10 ,,	11 ,,

Mojsisovics compared this species with *P. opulentus* v. Mojs. from the Muschelkalk of the Schreyer Alpe, but it differs therefrom chiefly by its more compressed whorls and its remarkable sculpture. The difference in the proportions of the last whorl is already noticeable at early stages of growth. Whereas in *P. opulentus* height and thickness of the last whorl become equal when the volution reaches a height of 34 mm; there are specimens among my material of this species, in which the volutions become higher than thick, even when the height of the last whorl reaches 20 mm only (Pl. XX. fig. 5). The specimen figured Pl. XX. fig. 4, is distinguished by a proportionately thick transverse section, but yet it is still more compressed, than individuals of *P. opulentus* with an equal height of the last whorl.

The wide and funnel-shaped umbilicus is surrounded by an obliquely inclined inner wall, which is separated from the sides by a rounded umbilical margin.

The sculpture consists of numerous, straight ribs which pass across the siphonal part. Stronger alternate with weaker folds, but not in a regular series.

Sutures.—Agree almost entirely with those of *P. opulentus*, the saddles being only very little broader. Nor do the lateral branches cut so deeply into the stems. Siphonal saddle very short and bulky. Third lateral saddle bipartite. The first auxiliary saddle coincides with the umbilical margin.

Locality, number of specimens examined.—Spiti, 1, Shangra, Hundes, 7; all from the coll. Schlagintweit in the Palæontological Museum in Munich.

16. (3) Ptychites Drona nov. sp. Pl. XVI., fig 3.

Dimensions	
Diameter of the shell	66 mm.
Height of the last whorl	33 ,,
Thickness ,, ,, ,, ,,	35 ,,
Diameter of the umbilicus	15 ,,

Ptychites Drona differs from the two other Indian species of this group by its globose shape and the broad rounded siphonal area. The outlines of the shell and the proportions of the last whorl recall *P. rugifer*, Oppel, but our form possesses three lateral lobes and its sutures are characterised by an arrangement peculiar to the group of the *P. opulenti.*

The umbilical margin is rather rounded, but sharply defined; umbilicus comparatively wide and umbilical walls high and steep. The involution takes place close to the umbilical margin; the inner volutions are exposed inside the umbilicus in the shape of a very narrow spiral band.

The surface of the shell is covered with numerous, delicate folds, which cross the sides and the siphonal part in the shape of rings. There are 22 of them in the last whorl.

Sutures.—The sutural line recalls the characters peculiar to the group of the *P. opulenti.* The siphonal saddle is even shorter than in *P. progressus*, v. Mojs. Both the second and the third lateral saddles end in two terminal branches, which, however, are not very strongly individualised. One auxiliary lobe outside the umbilical margin. The latter divides the first auxiliary saddle, when the last whorl reaches a height of 20mm. Two auxiliary lobes and an equal number of simple auxiliary saddles outside the umbilical suture.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 1, coll. Diener.

ζ. Group of the PTYCHITES FLEXUOSI.

17. (1) PTYCHITES COCHLEATUS, Oppel PL. XVII., fig. 3.

1865. *Ammonites cochleatus*, Oppel: Palaeontologische Mittheilgn. I Taf. 85, fig. 1, p. 294.
1865. *Ammonites Studeri*, v. Hauer, *ex parte*: Die Cephalopoden der unteren Trias der Alpen, Sitzgsber. Kais. Akad. d. Wiss. Wien LII. Bd. I. Abth. p. 629.
1867. *Ammonites Gerardi*, Beyrich, *ex parte*: Ueber einige Cephalopoden aus dem Muschelkalk der Alpen etc. Abhandlgn. Koenigl. Akad. d. Wiss. Berlin 1866, p. 127.
1882. *Ptychites cochleatus*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz Abh. k.k. Geol. Reichsanst. Vol. X. p. 261.

Dimensions.

Diameter of the shell	85 mm.
Height of the last whorl	45 „
Thickness „ „ „ „	38 „
Diameter of the umbilicus	16 „

The group of *Ptychites flexuosi* is represented in the Indian Muschelkalk by a form, which is closely allied to *P. Studeri*, v. Hauer, from the *Binodosus*—beds of the Mediterranean Triassic province. It has already been mentioned by E. v. Mojsisovics, that the Indian form differs in having thicker volutions and in the shape of its umbilicus. The latter is much wider than in *P. Studeri*, is funnel-shaped and surrounded by a high, obliquely inclined inner wall. The involution takes place quite close to the umbilical margin, and the umbilical walls of the inner volutions are arranged in one and the same plane. Inside the umbilicus the inner volutions are therefore only visible as a spiral line. The maximum thickness

of the whorls coincides with the umbilical margin. From this the slightly convex sides slope gently towards the rounded siphonal part.

The sculpture consists of radial folds, of which there are 18 to 20 on the last volution (whereas there are 22 to 24 in *P. Studeri*). In none of my specimens have I noticed a backward curved convexity in these folds near the siphonal margin, as is the case in *P. Studeri*. In both species, however, broad folds reach close to the umbilical margin, whilst less prominent, secondary ribs occur between them. None of the folds actually reach the umbilical margin proper. They also die out near the siphonal part, which remains perfectly smooth.

All my specimens are entirely chambered.

Sutures.—The vertical projection of the outline of the penultimate whorl meets the outer margin of the third lateral saddle in the outer whorl. Shape and arrangement of the sutural line almost agree with those in *P. Studeri*. Siphonal lobe very short and small, provided with a high siphonal tubercle. The principal lateral lobe is divided at its base into two symmetrical digitations by a larger point, as in *P. Studeri*. The following lobes end in a single terminal digitation, bordered symmetrically by lateral branches on each side. When the outer whorl reaches a height of 27mm the second auxiliary lobe coincides with the umbilical margin. Three auxiliary lobes and an equal number of bipartite auxiliary saddles outside the umbilical suture. The small narrow siphonal saddle is situated on the siphonal part.

Siphuncle.—In my two specimens from Rimkin Paiar I have been able to observe the narrow, horny siphuncle, provided only with single longitudinal fibres. Its structure agrees with the description given by E. v. Mojsisovics of the siphuncle of his species *P. Nordenskjoeldi*.[1]

Locality, number of specimens examined.—Kuling, Spiti, 1, coll. Schlagintweit, from the Palæontological Museum in Munich (Oppel's type-specimen); Shalshal cliff near Rimkin Paiar Encamping Ground, 2, coll. Diener; west slope of the Silakank Pass (Painkándha), 1, coll. Griesbach, Geological Museum in Calcutta.

18. (2) Ptychites Mahendra nov. sp. Pl. XVI., fig. 1, 2.

1865. *Ammonites Studeri*, Stoliczka: Mem. Geol. Surv. of India, Vol. V, Pt. I, p. 55.

Dimensions.

	(Fig. 1.)
Diameter of the shell	107 mm.
Height of the outer whorl	58 „
Thickness „ „ „ „	30 „
Diameter of the umbilicus	10·5 „
Diameter of the umbilicus of the cast	12 „

This species, which according to the number of its lateral lobes belongs to the '*Flexuosi*'-group, recalls in its general shape and involution *P. flexuosus*, E. v. Mojs.,[2] from the Mediterranean Muschelkalk.

P. Mahendra has a flat, discoidal shell, a narrow, highly rounded siphonal part,

[1] Neues Jahrb. f. Miner. 1886, Vol. II. p. 161.

[2] Abh. k.k. Geol. Reichsanst. Vol. X, Pl. LXIII, fig. 2-6; Pl. LXIV, fig. 1, 2, 3; Pl. LXVI, fig. 2, 3, p. 261.

and a funnel-shaped umbilicus, surrounded by an obliquely inclined inner wall. The umbilicus is narrower than in *P. cochleatus*, Oppel. The involution does not take place exactly at the umbilical margin. The inner volutions are exposed inside the umbilicus in the shape of narrow spiral bands, as in *P. Studeri*.

The transverse section of the two specimens of *P. Mahendra* resembles that of the flat, compressed variety of *P. flexuosus*, v. Mojs. The greatest thickness of the outer whorl about coincides with the middle portion of the sides. From this region the sides slope with a gentle convexity towards the siphonal part and to the somewhat rounded, though well-defined, umbilical margin.

The last volution possesses about 15 broad and flat ribs which rise exactly outside the umbilical margin and run in a straight and almost radial direction as far as the middle portion of the lateral parts. In the outer portion of the sides they are bent into a more or less strongly marked falciform curve with its convexity turned backwards, as in *P. flexuosus*. In the specimen from Muth (fig. 1) this flexuous curve of the folds in the upper portion of the sides corresponds with a height of the outer whorl of only 25 mm. On the inner volutions of my specimen from Rimkin Paiar with an equal height of the outer whorl, are perfectly straight ribs. It is only in the last volution that a slight falciform curve of the folds in the outer portion of the sides may be observed.

The rather well preserved shell is covered by numerous thin radial striations parallel to the direction of the folds; they are wrinkly and somewhat wavy, as in *P. flexuosus*. The growth-lines are bent forward obliquely on the inner wall of the umbilicus.

Sutures.—The vertical projection of the outline of the penultimate whorl meets the apex of the third lateral saddle on the outer whorl. The sutures of *P. Mahendra* differ from the lobe-line of *P. flexuosus* by more elongated and slender saddles and by the remarkable size of the siphonal saddle, which surpasses the second lateral saddle in height. The siphonal lobe is short and provided with a high pyramidal, denticulated siphonal tubercle. Five auxiliary lobes. Third auxiliary saddle bipartite.

Locality, number of specimens examined.—Muth, Spiti, 1, Coll. Geol. Survey Museum in Calcutta (Stoliczka's type-specimen); Shalshal Cliff near Rimkin Paiar Encamping Ground, 1, Coll. Diener.

Family: *ARCESTIDÆ.*

Sub-family: LOBITINÆ.

Genus: LOBITES. E. v. Mojsisovics.

The presence in the Muschelkalk of the Himálayas of the genus *Lobites* v. Mojs. appears as doubtful as that of the genus *Isculites* v. Mojs. The only hitherto known specimen of *Lobites Oldhamianus*, Stol., which represents this genus in the Indian Triassic province, has been collected in a dark limestone of unknown age at

Lilang on the Lingti River in Spiti. To judge from the matrix of the fossil I am rather disposed to refer it to upper triassic beds, than to Muschelkalk. Nor has the genus *Lobites* been met with in the Mediterranean Triassic province in lower horizons than in the Wengen beds of southern Tyrol, where it forms part of the Norian stage.

Lobites Oldhamianus Stoliczka. Pl. XXVII., fig. 4.

1865. *Clydonites Oldhamianus* Stoliczka: Mem. Geol. Surv. of India, Vol., Pt. I. p. 50; Pl. IV. fig. 4.

1873. *Lobites Oldhamianus*, E. v. Mojsisovics: Das Gebirge um Hallstatt I. Th., Abhandlgn. K. K. Geolog. Reichs-Anstalt, Bd. VI, p. 156.

1892. *Lobites Oldhamianus* E. v. Mojsisovics: Vorläufige Bemerkungen über die Cephalopoden-Faunen der Himalaya Trias; Sitzgsber. Kais. Akad. d. Wiss., Wien Bd. CI., 1. Abthlg. p. 376.

Dimensions.

Diameter of the shell	27 mm.
Height of the outer whorl	13 „
Thickness „ „ „ „	20 „
Diameter of the umbilicus	3 „

This specimen consists of a cast which unfortunately is entirely chambered. In the absence of the body-chamber a satisfactory diagnosis of the species is therefore impossible, and it is an open question, to which of the Mediterranean groups *Lobites Oldhamianus* may be most closely allied.

Characteristic of this species, besides its considerable size, is the very thick globose shape, with broad section of the last whorl and the proportionately wide open umbilicus, surrounded by a tolerably high, steeply inclined inner wall.

The sculpture consists of numerous, delicate radial ribs, which are partly single and partly rise in pairs from near the umbilical margin. On the sides, some of these ribs become dichotomous.

Sutures.—The septa are remarkably distant even in the outer volution. The arrangement of the sutural line recalls *L. ellipticus* v. Hauer. [1]

Two lateral lobes as in the congeneric species of the Mediterranean Triassic province. Siphonal lobe terminates in two points, provided with a broad siphonal tubercle. The remaining lobes lanceolate. The saddles are strongly contracted at their base. The principal lateral saddle is remarkably small. Two auxiliary lobes and an equal number of auxiliary saddles. The broad second auxiliary saddle is divided by the umbilical suture.

Locality, number of specimens examined.—Lilang, Spiti, 1, Coll. Geolog. Survey Museum in Calcutta (Stoliczka's type-specimen).

Sub-family: ARCESTINÆ

Genus: PROARCESTES, E. v. Mojsisovics.

In the Himálayan Trias the sub-family of the *Arcestinæ* plays a far inferior rol! than in the equivalent Mediterranean deposits. This fact is very clearly seen in the Upper Trias of the Himálayas, where the genus *Arcestes* is extremely poor in

[1] E. v. Mojsisovics, Das Gebirge um Hallstatt I. Th. l. c. Taf. LXIX. fig. 3, p. 161.

number of species, as well as in individuals. A similar remark applies to the geologically older genus *Proarcestes* which is represented in the Indian Muschelkalk by only two species; one of them *Proarcestes Balfouri*, Oppel, belonging to the European group of *Proarcestes Bramantei*, v. Mojs.

1. Proarcestes Balfouri Oppel. Pl. XXVII., fig. 6, 7.

1863. *Ammonites Balfouri* Oppel: Palæontologische Mitth. I. Taf 80. fig. 5, p. 285.
1865. *Ammonites Aussecanus*, Stoliczka *ex parte*: Mem. Geol. Survey of India, V. Pt. I. p. 53.
1882. *Arcestes Balfouri*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz. Abh. k.k. Geol. Reichsanst. Vol. X. 162.

Dimensions.	I.	II.
Diameter of the shell	59 mm.	47 mm.
Height of the last whorl	27 „	21 „
Thickness „ „ „ „	46 „	37 „
Diameter of the umbilicus	4 „	?

Mojsisovics noticed the very close resemblance, which this form bears to *Proarcestes Escheri*, v. Mojs., [1] from the Muschelkalk of the Schreyer Alpe (Salzkammergut). This resemblance is so great, that the question, whether these forms are not altogether identical, will have to remain open till specimens of *P. Balfouri* with body-chamber are found.

Besides Oppel's entirely chambered type-specimen, I possess a second specimen from the Tsang-Tsok-La in Hundés for description, of which nearly one half of the outer volution belongs to the body-chamber. Even this specimen, however, is not in a good enough state of preservation to decide the question raised by E. v. Mojsisovics, as the deep contractions, so characteristic in *Proarcestes Escheri* are only found in the anterior part of the body-chamber of full-grown individuals. In the preserved portion of the body-chamber and in the inner volutions neither *labiae* nor *varices* are seen. The surface of the cast is perfectly smooth. The only difference between the two forms seems to consist in a greater thickness of the outer whorl in *Proarcestes Balfouri*.

In the specimen from the Tsang-Tsok-La an open umbilicus is associated with a diameter of 59 mm.

The shell is partly preserved in Oppel's type-specimen and is seen to be covered with very numerous and delicate transverse striations, which run from the umbilicus across the sides in a forward bent direction and pass across the siphonal area in a straight line.

Sutures.—Perfectly identical with those of *P. Escheri*, even in the minor details of ornamentation. Three auxiliary lobes outside the umbilical margin.

Locality, number of specimens examined.—Dras (?), Hundés (locality somewhat doubtful), 1, Coll. Schlagintweit, from the Palæontological Museum, Munich (Oppel's type-specimen), Tsang-Tsok-La, Hop Gádh, Hundés, 1, Coll.

[1] l.c. Taf. XLVI. fig. 7, 8, 9. p. 162 and Das Gebirge um Hallstatt I. Theil Abh. kk. Geol. Reichs. Vol. VI. Pl. LVIII. fig. 18, p. 112.

Griesbach, Geological Survey Museum, Calcutta; Lilang, Spiti, 1, Coll. Stoliczka, Geological Survey Museum, Calcutta.

2. Proarcestes bicinctus E. v. Mojs. Pl. XXVIII. fig. 1.

1865. *Ammonites diffissus*, Stoliczka: Geol. Surv. of India, Vol. V. Pt. I. p. 53; Pl. V. fig. 4.

1882. *Arcestes bicinctus*, E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst. Vol. X. p. 167.

Dimensions.

Diameter of the shell	39 mm.
Height of the outer whorl	19 „
Thickness „ „ „ „	37 „
Diameter of the umbilicus	6·5 „

Stoliczka identified this form erroneously with *Joannites diffissus*, v. Hauer. Its relationship to the genus *Arcestes viz.*, *Proarcestes*, was first noticed by Mojsisovics, who in 1873 [1] proved that the forms identified with *Ammonites diffissus* by Salter and by Stoliczka[2], differ from the genuine *Joannites diffissus*, v. Hauer, and from each other. Mojsisovics proposed the name *Proarcestes bicinctus* for this form on the ground of Stoliczka's figure of its sutural line. This figure however, does not give a correct idea of its sutural elements, as may be easily seen from a comparison with Pl. XXVIII. fig. 1c.

The only specimen which serves for description—Stoliczka's type-specimen—is but imperfectly preserved and not sufficient for a satisfactory diagnosis of the species. It is scarcely worthy to be distinguished by a specific name. Only the posterior part of the body-chamber is preserved, including about one-fourth of the last volution. Thus it cannot be decided, to which of the Mediterranean groups of *Proarcestes* this species belongs.

P. bicinctus, E. v. Mojs., may be said to be chiefly characterised by the extraordinary thickness of the outer whorl, which is almost equal to the diameter of the species, the contractions in the last volution and a comparatively wide and deep umbilicus, bordered by a high, perpendicular inner wall. Umbilical margin rounded. Only one flat contraction is seen in the last whorl immediately before the posterior termination of the body-chamber. It reaches from the umbilical margin across the lateral parts, but becomes obsolete in the siphonal area.

Shell not preserved.

Sutures.—Neither the siphonal lobe nor the siphonal saddle could be traced. The most important elements for a comparison with the sutural lines of Mediterranean *Arcestinæ* are therefore wanting. Saddles less richly ramified than in the group of *P. Bramantei* v. Mojs. The vertical projection of the outline of the penultimate whorl meets the inner margin of the second lateral saddle of the outer volution. Three auxiliary lobes outside the umbilical suture, which divides the third auxiliary lobe.

Locality, number of specimens examined.—Lilang, Spiti, 1, Coll. Geological Survey Museum in Calcutta (Stoliczka's type-specimen).

[1] Das Gebirge um Hallstatt I. Theil. l.c. p. 86.

[2] Palæontology of Niti, p. 64 Pl. 7, fig. 2.

Nov. Genus ind. ex. fam. Arcestidarum sp. ind. Pl. XXVIII. fig. 2, 3.

Dimensions.	
Diameter of the shell	27 mm.
Height of the outer whorl	15 „
Thickness „ „ „	28 „
Diameter of the umbilicus	0 „

This form differs so considerably from *Proarcestes* in some of its essential characters, especially in the complete absence of *labiæ* or *varices*, and in the shape of its sutures, that it cannot be left in this genus.

The type of *Arcestinæ* is principally shown in its outlines. It is very globose similar to *P. bicinctus*, v. Mojs., but the volutions overlap still more closely and are so thick, that the width of the outer whorl amounts to almost double its height. The siphonal area is obtusely rounded. The sides are almost smooth provided only with very delicate spiral striations.

The umbilicus is closed by a callosity. Neither *labiæ* nor *varices* have been noticed in my specimens, although in one of them, the body-chamber is almost entirely preserved.

The body-chamber consists at least of one and a half volutions. The last volution does not differ in its shape from the inner ones.

Sutures.—The arrangement of the sutural elements is the same as in *Proarcestes*, but the saddles are distinguished by their extraordinary slenderness. Their stems do not divide into horizontal, bifurcating branches, as in *Proarcestes*, but are dolichophyllic and terminate in a pointed sphærophyllic foliation, as they do in the representatives of the genus *Monophyllites*.

This form has only two auxiliary lobes.

Locality, number of specimens examined.—Shalshal cliff near Rimkin Paiar Encamping Ground, 2, coll. Diener.

Remarks.—The shape of the saddles is so entirely different from that of any species of *Proarcestes*, that this form must undoubtedly be considered to hold an independent generic position. Unfortunately my material is too poor to allow more than a statement of this fact.

II. NAUTILEA.

Family: *NAUTILIDÆ.*

Sub-family: NAUTILINÆ.

Genus: NAUTILUS, Breynius.

1. Nautilus Griesbachi nov. sp. Pl. XXVIII., fig. 6, 7.

Dimensions.	I. (fig. 7.)	II. (fig. 6.)
Diameter of the shell	88 mm.	49 mm.
Height of the outer whorl	49 „	25 „
Thickness „ „ „	27 „	19 „
Diameter of the umbilicus	17 „	11 „

This species has rapidly increasing volutions, which overlap each other to the extent of more than half their height. The greatest thickness of the outer whorl coincides with the umbilical margin. The umbilical margin is slightly rounded and separated from the umbilical suture by a high and perpendicular inner wall. The siphonal area is flatly rounded. The elliptical shape of the figured specimens is probably due to later deformation in the matrix.

The shell, as far as it could be examined, is smooth and provided with simple striae of growth.

Sutures.—Lateral lobe deeply sinuous, rounded below, siphonal lobe very shallow. Internal lobe present.

Siphuncle.—Below the centre of the septum.

Remarks.—Among the *Nautili* of the Alpine Muschelkalk, *N. Palladii* v. Mojs.,[1] is very closely allied to this species. *N. Griesbachi*, however, has more compressed whorls, a higher aperture and a deep umbilicus, surrounded by a perpendicular inner wall.

Locality, number of specimens examined.—North of Kalapani, Kali River Valley, Byans, 3, coll. Griesbach, Geological Survey Museum, Calcutta.

2. Nautilus sp. ind. ex aff. N. Griesbachi, Pl. XXVIII., fig. 4.

The figure refers to a fragment from the Muschelkalk of the Shalshal cliff near Rimkin Paiar Encamping Ground, which belongs to a *Nautilus* closely allied to the preceding species. The arrangement of the sutures agrees almost, entirely. The siphonal area is flat and is more distinctly separated from the lateral parts than in *Nautilus Griesbachi*. The principal difference consists in the greater thickness of the outer whorl which is equal to the height of the volution, *i.e.* 46 mm.

3. Nautilus Spitiensis Stoliczka. Pl. XXVIII., fig. 5.

1865. *Nautilus Spitiensis* Stoliczka: Mem. Geol. Surv. of India. V. Pt. I. p. 49. Pl. IV. fig. 2.

1882. *Nautilus Spitiensis* E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst. Vol. X. p. 286.

Dimensions.

Diameter of the shell	42mm.
Height of the outer whorl	18 „
Thickness „ „ „ „	16 „
Diameter of the umbilicus	12 „

This species is nearly allied to the Alpine *N. Lilianus*, which was pointed out by E. v. Mojsisovics.[2] It has slowly increasing volutions which scarcely overlap, flat and parallel sides, a broadly rounded siphonal area and a wide umbilicus, bordered by a steep inner wall. The umbilical margin is rounded. Transverse section sub-angular.

The shell consists of only two volutions. The outer whorl contains the posterior termination of the body-chamber.

[1] Abh. k.k. Geol. Reichsanst. Vol. X. Pl. XCII. fig. 2, p. 285.
[2] Abh. k.k. Geol. Reichsanst. Vol. X. LXXXII. Pl. fig. 3, 4, p. 286.

The shell, which is but partly preserved, is covered with numerous, thin transverse striæ.

Sutures.—The septa are comparatively close to each other and pass in an almost straight line across the siphonal area. The deepest point of the distinctly defined but shallow, lateral lobe, coincides with the middle of the sides. Internal lobe present.

Siphuncle.—Above the centre of the septum.

Locality, number of specimens examined.—Lilang, Spiti, 1, Geological Survey Museum, Calcutta,—Stoliczka's type-specimen.

Family. *ORTHOCERATIDÆ.*

Genus ORTHOCERAS Breynius.

1. ORTHOCERAS CF. CAMPANILE, E. v. Mojsisovics. Pl. XXVIII., fig. 8.

1882. *Orthoceras campanile* E. v. Mojsisovics: Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst. Vol. X. p. 291, Taf. XCIII. fig. 1, 2, 3, 4, 11.

The only somewhat better preserved specimen of *Orthoceras* which I collected in the Himálayan Muschelkalk, agrees in all essential characters with *Orthoceras campanile* from the Mediterranean Trias as far as an exact determination is possible. Central position of the siphuncle and closely situated septa characterise our specimen. The distance of the different septa from each other equal to two-thirds of the diameter of the lower chamber. To a diameter of the last preserved septum of 12·5mm, corresponds a height of the lower chamber of 9·5mm.

Angle of emergency about 4°. Shell not preserved.

Locality, number of specimens examined.—Southern slope of the Uta-Dhura Pass (Johár), 1, Coll., Diener.

2. ORTHOCERAS SP. IND. EX. AFF. O. CAMPANILE, v. Mojsisovics Pl. XXVIII. fig. 10.

1865. *Orthoceras dubium* Stoliczka, Mem. Geolog. Survey of India, Vol. V. Pt. I p. 48.

Among the Triassic Cephalopoda in the collection of the Geological Survey Museum in Calcutta, there are a good many chambered fragments of an *Orthoceras*, which Stoliczka erroneously identified with *Orthoceras dubium*, v. Hauer. This *Orthoceras* apparently agrees with *Orthoceras campanile*, v. Mojs.[1] in some of its essential characters, but differs therefrom by a lesser distance between the septa being only equal to one-half of the diameter of the preceding chamber.

Transverse section circular. Siphuncle central, only in consequence of later deformation apparently eccentric in the figured specimen. Shell not preserved.

Locality, number of specimens examined.—Parang Pass (Spiti), 2, Lilang, Spiti, 1, coll. Geological Survey Museum in Calcutta; Shalshal cliff near Rimkin Paiar encamping ground, 1, Coll. Diener.

Remarks.—The fragments, identified with *Orthoceras lateseptatum*, v. Hauer,

[1] l. c. p. 291.

and with *Orthoceras salinarium* by Stoliczka[1] are too badly preserved to permit specific determination.

DIBRANCHIATA.

Family: *BELEMNITIDÆ.*

Sub-family: AULACOCERATINÆ.

Genus ATRACTITES, Gümbel.

ATRACTITES sp. ind. Pl. XXVIII. fig. 9.

In order to prove that *Atractites* occurs in the Muschelkalk of the Central Himálayas, I have figured the fragment of a chambered phragmocone from the Parang Pass in Spiti.

Phragmocone with a circular section and with an angle of divergency of about 15°. Septa close to each other and running straight across the ventral side. Their distance is considerably less than half the diameter of the preceding chamber.

Shell smooth, as far as preserved.

Locality, number of specimens examined.—Parang Pass, Spiti, 2, Coll. Geological Survey Museum in Calcutta.

FAUNISTIC RESULTS.

The fauna of the cephalopoda of the Muschelkalk in the main region of the Himálayas comprises the following forms:—

1. *Ceratites Wetsoni*, Oppel.
2. " *sp. ind. ex aff. C. Wetsoni.*
3. " *Voiti* Oppel.
4. " *Ravana*, Diener.
5. " *nov. sp. ind. ex aff. C. Ravana.*
6. " *nov. sp. ind. ex aff. C. Ravana.*
7. " *Airavata*, Diener.
8. " *nov. sp. ind.*
9. " *Hidimba*, Diener.
10. " *sp. ind. ex aff. C. Hidimba.*
11. " *Dungara*, Diener.
12. " *Visvakarma*, Diener.
13. " *Arjuna*, Diener.
14. " *onustus* Oppel.
15. " *Vyasa*, Diener.

[1] l. c. p. 4.

16. *Ceratites sp. ind. ex aff. C. Vyasa.*
17. „ *nov. sp. ind. ex aff. C. Zoldiano*, v. Mojs.
18. „ *Thuillieri*, Oppel.
19. „ *Himalayanus*, Blanf.
20. „ *Kamadeva*, Diener.
21. „ *Kuvera*, Diener.
22. „ *truncus*, Oppel.
23. „ *nov. sp. ex aff. C. subrobusto*, v. Mojs.
24. „ *sp. ind. ex aff. C. Middendorfi*, Keyserl.
25. „ *nov. sp. ind. ex aff. C. Geminato*, v. Mojs.
26. „ *sp. ind. ex aff. C. Geminato* (?).
27. *Danubites Dritarashtra*, Diener.
28. *Japonites Sugriva*, Diener.
29. „ *Chandra*, Diener.
30. „ *runcinatus*, Oppel.
31. *Acrochordiceras Balarama*, Diener.
32. „ *Johareuse*, Diener.
33. *Sibirites Prahlada*, Diener.
(?) 34. *Isculites Hauerinus*, Stoliczka.
35. *Proarcestes Balfouri*, Oppel.
36. „ *bicinctus*, E. v. Mojs.
37. *Nov. genus ind. ex fam. Arcestidarum sp. ind.*
(?) 38. *Lobites Oldhamianus*, Stol.
39. *Meekoceras Khanikofi*, Oppel.
40. „ *Kesava*, Diener.
41. „ *proximum*, Oppel.
42. „ *Nalikanta*, Diener.
43. „ *Srikanta*, Diener.
44. „ *Narada*, Diener.
45. „ *affine*, E. v. Mojs.
46. „ *Nanda*, Diener.
47. „ *Gangadhara*, Diener.
48. „ *Rudra*, Diener.
49. *Gymnites Jollyanus*, Oppel.
50. „ *Vasantasena*, Diener.
51. „ *Kirata*, Diener.
52. „ *Salteri*, Beyrich.
53. „ *Sankara*, Diener.
54. „ *nov. sp. ex aff. G. Sankara.*
55. „ *sp. ind. ex aff. G. Humboldti*, v. Mojs.
56. „ *Lamarki*, Oppel.
57. *Buddhaites Rama*, Diener.
58. *Sturia Sansovinii*, E. v. Mojs.
59. *Ptychites rugifer*, Oppel.
60. „ *Tibetanus*, E. v. Mojs.
61. „ *Mangala*, Diener.
62. „ *Sukra*, Diener.
63. „ *cognatus*, Oppel.
64. „ *Asura*, Diener.

65. *Ptychites Govinda*, Diener.
66. „ *impletus*, Oppel.
67. „ *Sahadeva*, Diener.
68. „ *Sumitra*, Diener.
69. „ *Mallelianus*, Stoliczka.
70. „ *nov. sp. ind. ex aff. P. Malletiano.*
71. „ *Gerardi*, Blanf.
72. „ *Everesti*, Oppel.
73. „ *Vidura*, Diener.
74. „ *Drona*, Diener.
75. „ *cochleatus*, Oppel.
76. „ *Mahendra*, Diener.
77. *Nautilus Griesbachi*, Diener.
78. „ *sp. ind. ex aff. N. Griesbachi.*
79. „ *Spitiensis*, Stol.
80. *Orthoceras cf. campanile*, E. v. Mojs.
81. „ *sp. ind. ex. aff. O. campanile.*
82. *Atractites* sp. ind.

The character of this fauna fully justifies the opinion of Beyrich, E. v. Mojsisovics, Griesbach a. o., who correlated the beds containing these fossils with the European Muschelkalk. The assemblage of species from these beds forms indeed a typical Muschelkalk fauna. One look at the representatives of the genera *Ceratites*, *Meekoceras*, *Gymnites*, and *Ptychites* is sufficient to prove the correctness of this view. The above list includes only two genera, *Lobites* and *Isculites*, confined to upper-triassic beds in the Alpine province, but I am not satisfied that these two forms were really obtained in the Muschelkalk of Spiti by Stoliczka.

In the fauna of the Himálayan Muschelkalk two species also occur elsewhere in beds of the same horizon, namely: *Sturia Sansovinii*, E. v. Mojs., the well-known leading fossil of the zone of *Ceratites trinodosus* in the Mediterranean Trias, and *Meekoceras affine*, E. v. Mojs., in the Muschelkalk of Mengilæch on the Olenek River in North-Eastern Siberia. Most probable is also the identity of an *Orthoceras* from the Utadhura pass in Kumaon, with *Orthoceras campanile*, v. Mojs., from the Upper Alpine Muschelkalk. Also *Proarcestes Balfouri*, Oppel may possibly be included in this list, as according to our present state of knowledge, no essential difference is known between this form and *Proarcestes Escheri*, v. Mojs., from the red limestone of the Schreyer Alpe (zone of *Ceratites trinodosus*).

As has already been observed by E. v. Mojsisovics[1] in 1886, the Muschelkalk of the Indian Triassic province takes an intermediate position between the Arctic-Pacific and the Mediterranean[2] Muschelkalk. This view is not only confirmed by

[1] Arktische Triasfaunen, Mém. de l' académie impér. des sciences de St. Pétersbourg, VII Sér. T. XXXIII, No. 6, p. 154.

[2] The term "Mediterranean" is here used in the same sense as by Neumayr, who speaks of a Central Mediterranean Sea of the Jurassic age. To this Jurassic Mediterranean Sea a similar Triassic Sea corresponds, which reached from the Ebro valley eastwards. The Alpine Trias is to be considered as a standard type of its deposits.

the present investigations, but it appears now even possible to trace out more completely the relations which connect the faunas of these three provinces during the Muschelkalk stage.

The relations with the Mediterranean Muschelkalk are most clearly indicated by the occurrence of numerous closely allied forms in the two areas belonging especially to the genera *Gymnites* and *Ptychites*. It has been said before, that *Sturia Sansovinii*, and probably also *Orthoceras campanile* and *Proarcestes Balfouri* (—*Escheri*= ?) are identical.

Among the *Ceratites* two species of the "*Nodosi*", *Ceratites Thuillieri*, Oppel and *Ceratites Himalayanus*, Blanf., are very closely allied to *Ceratites trinodosus*, v. Mojs. The *Ceratites nodosi*, it is true, play a rather subordinate roll in the Indian Triassic province and in number of species are far surpassed by the group of the "*Circumplicati*," comparatively rare in the Alpine Trias. But it is just among the latter that two isolated Alpine types, *Ceratites Erasmi*, v. Mojs., and *Ceratites Zezianus*, v. Mojs., are represented in the Himálayas by closely allied forms.

The only species of *Danubites* hitherto known from the Muschelkalk in the Central Himálayas, belongs to the Mediterranean group of *Danubites floriani*, v. Mojs.

In this respect the presence of the genus *Acrochordiceras* in the Indian Muschelkalk is equally remarkable, although neither of the two Indian species possesses a closer relationship to any form of the Alpine Trias. In the Arctic-Pacific province the genus *Acrochordiceras* is not known from beds of Muschelkalk age, but makes its first appearance in the lowest division of the Star-Peak-group of California and Nevada, considered by v. Mojsisovics as an equivalent of the Norian stage. In the Ceratite-beds of the Salt-range, forming part of the Indian Triassic province, the oldest representative of this genus has been found even in lower triassic[1] beds.

The genus *Meekoceras*, which is distinguished in the Indian Muschelkalk by its richness in forms, contains a considerable number of species, which are very closely allied to the Alpine *M. Reuttense*, Beyrich. Most of the numerous species of *Gymnites* also bear a close relationship to Mediterranean forms, especially to *Gymnites Humboldti*, v. Mojs., and *G. obliquus*, v. Mojs., and *G. incultus*, Beyrich. G. *acutus*, v. Hauer, from the upper Muschelkalk of Bosnia, which, till now, was isolated in the Mediterranean Trias, has an Indian ally in *G. Lamarki*, Oppel, which is equally distinguished by a sharpened siphonal area.

Among the *Ptychites* it is principally the group of the *Megalodisci*, in which the faunistic relations between the two zoo-geographical provinces are most distinctly marked. The Himálayan *P. Sumitra* differs from the Alpine *P. megalodiscus*, Beyrich, only in very subordinate details, whereas the two other Indian species of this group, *P. impletus*, Oppel, and *P. Sahadeva*, belong to the relationship of *P. Pauli*, v. Mojs. The group of the *Opulenti* is represented in the Himálayan Muschelkalk

[1] W. Waagen: Vorläufige Mittheilung über die Ablagerungen der Trias in der Salt-Range, Jahrbuch K. K. Geolog. Reichs-Anstalt 42. Bd., 1892, p. 380.

exclusively by forms closely allied to *P. progressus*, v. Mojs., or to *P. opulentus* v. Mojs., from the Upper Alpine Muschelkalk. Among the *Rugiferi*, *P. cognatus*, Oppel, has its nearest relation in *P. Stachei*, v. Mojs., from the *Trinodosus* beds of the Bakony forest in Hungary. In the group of the *Flexuosi* a relationship may be observed between *P. cochleatus*, Oppel, and *P. Studeri*, v. Hauer, on one hand, and between *P. Mahendra* and P. *flexuosus*, v. Mojs. on the other.

Among the *Nautilidæ* of the Himálayan Muschelkalk *N. Griesbachi*, is related to *N. Palladii*, v. Mojs., and *N. Spitiensis*, Stol., to *N. Lilianus*, v. Mojs.

The faunistic relations between the Himálayan Muschelkalk and the Arctic-Pacific Trias are almost equally close. Most likely these relations would appear much more evident if we knew more of the cephalopod-bearing strata of the Muschelkalk of the latter province. Only the fauna of the *Daonella* limestone of Spitzbergen and the faunulæ from Mengilaech on the mouth of the Olenek river and from the Magyl rocks on the lower Jana, which are assumed to be equivalents of the European Muschelkalk, permit a direct comparison. The *Posidonomya* limestone of Spitzbergen represents probably a very low horizon of the Muschelkalk. The Olenek beds of Eastern Siberia with *Ceratites subrobustus*, v. Mojs., are homotaxial with the Werfen beds of the Alps, as was pointed out by v. Mojsisovics. In Western America the "*Meekoceras* beds" of Idaho approach the Olenek beds closely as regards their geological position. The Star-Peak-group of California and Nevada, as well as the cephalopod-bearing strata of the Sakawa basin and of Rikuzen in Japan, are considered by v. Mojsisovics ("Arktische Triasfaunen," l. c. p. 148, and "Ueber einige Japanische Trias-fossilien," Beiträge zur Palæontologie Osterreich-Ungarns und des Orients, Vol. VII, Wien 1888) to be a homotaxial equivalent of the Norian stage. According to more recent communications of A. Hyatt (Jura and Trias of Taylorville, California, Bulletin of the Geological Society of America, Vol. 3, Rochester, 1892, p. 395), however, the Trias in the Western States of North America seems to include several horizons of different ages. The cephalopod-bearing strata of the Star-Peak-Range itself (Humboldt Region, Nevada), Hyatt correlates with the Muschelkalk, although without giving decisive proofs for his suggestion. The Trias of Taylorville (California), on the contrary, contains a good number of Carnian and Juvavic types, pointing to a doubtless younger age. To judge from fossils lately described by J. F. Whiteaves, especially from the *Protrachyceras*, (Pl. XVIII, fig. 4, Contributions to Canadian Palæontology, Vol. I, Pt. II, Montreal, 1889, p. 127 ff,) the triassic fossiliferous rocks of British Columbia, Vancouver, and Queen Charlotte Islands may be approximately correlated with the Noric stage. A genuine Muschelkalk fauna has not been detected yet in the countries surrounding the modern Pacific Ocean.

I may at once state my opinion, based on the examination of the lower-triassic cephalopoda of the Himálayas, that apparently close faunistic relations exist between the lower Trias of the Himálayas and the Olenek beds of Siberia; *Ceratites subrobustus* v. Mojs., one of the leading species of the Siberian Trias, being present in the Himálayas below the Muschelkalk between the horizon of *Sibirites Prahlada*

and the *Otoceras* beds of Griesbach. If we knew a fauna of the ***Muschelkalk*** as rich in cephalopoda as that of the Olenek beds from the area of the Pacific basin, probably there might appear a much closer faunistic connection between the two neighbouring provinces than we are at present able to prove.

E. v. Mojsisovics emphasises the remarkable fact that the Mediterranean genus *Tirolites* is not present in these two regions.[1] The genus *Balatonites*, which is most probably derived from *Tirolites*, is missing in the Spitzbergen Muschelkalk, nor has it been found in the equivalent deposits of the Himálayas.[2] As regards the relations between the Indian and Arctic-Pacific Muschelkalk faunas, we must observe the predominance of the *Ceratites* of the *Circumplicati*-group, especially of forms derived from *Ceratites polaris*, v. Mojs., or allied species. With regard to this point, I may refer to my remarks in the introduction to the description of *Ceratites*. There are, moreover, some analogous species in the Himálayan Muschelkalk among the groups of *Ceratites subrobusti* and *Ceratites geminati* which are peculiar to the Trias of the Arctic-Pacific province. Most interesting is the presence of the subgenus *Japonites*, represented in the Himálayan Trias by three species, one of which (*Japonites Sugriva*) is very closely allied to *Japonites planiplicatus*, v. Mojs., from the triassic deposits of Japan. In the Mediterranean Triassic province the genus *Sibirites* makes its first appearance in beds of the Juvavic stage, but it is present in the lower triassic Olenek beds of Siberia. In the Himálayas it characterizes the lower division of the Muschelkalk, and in the Ceratite beds of the Salt Range it also occurs in numerous species, as may be seen from Waagen's preliminary notes.[3] The close relations of the Indian *Ptychites* of the *Rugiferi* group to the congeneric forms of the Spitzbergen Muschelkalk have been noticed by E. v. Mojsisovics in his paper on the Arctic fauna of the Trias,[4] and was shown more fully in the preceding descriptions of *Ptychites rugifer*, Oppel, and *Ptychites Tibetanus*, v. Mojs.

The presence of *Meekoceras affine*, v. Mojs., in the Muschelkalk of the Indian Triassic province is of still greater importance.

This species, which in its general shape and in the development of its sutures resembles closely the congeneric forms of the European Muschelkalk, was collected by Czekanowski in a dark limestone below Mengilaech, near the mouth of the Olenek river, together with *Hungarites triformis*, v. Mojs., and *Monophyllites sp. ind.*—E. v Mojsisovics, who examined Czekanowski's collections, suggested that this fauna occupies a higher geological position in the general sequence than the true Olenek beds.[5] This view was afterwards confirmed by the discovery of a cephalopod fauna in the Magyl rocks on the lower Jana by Baron E. Toll. This fauna is geologically younger than that of the Olenek beds, and according to its geological character

[1] Arktische Triasfaunen, l. c. p. 149.

[2] According to Waagen (Jahrb. K. K. Geol. Reichs. Anst. 42, Bd. 1892, p. 382), in the Bivalve beds of the Salt Range the genus *Balatonites* is probably represented, although by a rather doubtful species.

[3] L. c. p. 382.

[4] Arktische Triasfaunen, L. c, p. 142.

[5] L. c. p. 83, 96.

points to Muschelkalk age: it also contains ***Meekoceras affine*** v. Mojs., and ***Hungarites triformis***[1]. The presence of ***Meekoceras affine*** in the true Muschelkalk of the Himálayas satisfactorily proves the correctness of this suggestion, which is based on palæontological evidence only.

It results from these facts that the Himálayan Muschelkalk forms a connecting link between the equivalent deposits of the Arctic-Pacific and Mediterranean provinces. It contains, however, a considerable number of peculiar faunistic elements which impart to the Indian Triassic province the character of a zoo-geographical region of its own.

To these faunistic elements peculiar to the Indian Trias belongs principally the strange group of ***Gymnites Rama***, which appeared to me to justify the establishment of a special sub-genus (***Buddhaites***). In my description of this form I have pointed to its relationship with ***Carnites***, hitherto likewise isolated in the Mediterranean Trias. Among these faunistic elements peculiar to the Indian Trias must be mentioned the groups of ***Ptychites Malletianus***, Stol., and of ***Ptychites Gerardi***, Blanf. representing types which differ completely from the ***Ptychites*** of the Mediterranean and Arctic-Pacific provinces. Among the ***Ptychites*** of the ***Rugiferi*** group I have to mention here ***Ptychites Govinda*** and ***Ptychites Asura***. In the genus ***Meekoceras*** we meet two isolated forms—***Meekoceras Gangadhara*** and ***Meekoceras Rudra***. The first of them is distinguished by its obliquely sloping, serrated umbilical lobe; the second by a circular arrangement of its sutures. Among the ***Ceratites circumplicati*** there exists a great divergence between the form figured Pl. IV., fig. 4, which is but imperfectly known, and the rest of the Indian species of this group. The like applies to ***Ceratites Kamadeva*** in the group of the ***Ceratites nodosi***. It has already been mentioned that none of the Indian representatives of the genus ***Acrochordiceras*** bears a closer relation to any of the Mediterranean congeneric species.

As to their number, the ***Ceratites*** play the most important roll in the Himálayan Muschelkalk. They are represented by 26 species, among which the ***Circumplicati*** (with 17 species) by far predominate, and thus show clearly the close relations to the Arctic-Pacific Trias. Remarkable in richness of forms are the genera ***Meekoceras*** and ***Gymnites***. The first of these two genera, which appear already in the lower Trias of the Himálayas in several species, reaches here the height of its development (with ten species). ***Gymnites*** (with 8, or rather 9, species) and ***Ptychites*** are confined exclusively to the Himálayan Muschelkalk. The genus ***Ptychites***, represented by 18 species, with exception of the ***Subflexuosi***, comprises all the groups known hitherto in the Mediterranean Trias, and besides them two more, peculiar to the Indian province. Compared with the above mentioned genera, all the rest remain far behind. They are of importance, however, because in the Himálayas ***Japonites***, ***Acrochordiceras***, and ***Sturia*** are exclusively characteristic

[1] E. v. *Mojsisovics*, Ueber einige arktische Trias-ammoniten des nordlichen Sibirien, Mém. del'acad. impér. des sciences de St. Pétersbourg VII. série. T. XXXVI, No. 6, 1888, p. 20.

of the Muschelkalk, and have never been met with, either at a higher or at a lower horizon. The absence of the genus *Monophyllites* in the main region of the Central Himálayas is rather strange, it being represented by a considerable number of species in the limestones of Chitichun (Hundés), which is equivalent to lower Muschelkalk.

It has been mentioned in the introduction that in the main region of the Central Himálayas the Muschelkalk may stratigraphically be divided into two sections. The lower division, rarely more than 3, never more than 6 ft. in thickness, consists of dark, sometimes earthy limestones, and is mostly of a brachiopod facies with a fauna rich in individuals, but very poor in species. In this division only one single Ammonite has been found, *Sibirites Prahlada*, with sutures still in a low stage of development, as in the Arctic *Sibirites*, but distinguished by a remarkably rich sculpture, which recalls geologically younger forms from the Juvavic stage.

That these beds form part of the Muschelkalk is proved by their close stratigraphical connection with the latter and by my observations in the section of the Shalshal cliff near Rimkin Paiar encamping ground. In this section between the *Otoceras*-beds of Griesbach and the dark limestone with *Sibirites Prahlada* a lower-triassic horizon is intercalated, distinguished by the presence of numerous *Danubites* and of *Ceratites subrobustus*, v. Mojs. This horizon may consequently be considered as a homotaxial equivalent of the Olenek-beds or of the Alpine Werfen-beds. As the limestones with *Sibirites Prahlada* occupy a higher place in this sequence, they may be correlated approximately to the lowest Muschelkalk.

The overlying main mass of the Muschelkalk, a hard, frequently concretionary limestone, is principally represented by a cephalopod-facies and forms a very important guide to the geologist in the Central Himálayas, owing to its regular occurrence and to its wide-spread distribution. Frequently some of its layers are completely filled with the shells of *Ceratites*, *Ptychites* or *Meekoceras*, but owing to the tough nature of the matrix it is rarely possible to obtain well preserved specimens. Compared with the cephalopoda, other fossils are extremely rare. No further subdivisions can be distinguished in this rock group, which has a thickness of 15 to 40m., as its beds contain all one and the same fauna. In the section of the Shalshal cliff, where I collected systematically, the *Meekoceratidæ* occupy mostly a lower position and the *Ptychitidæ* a higher one. Some of the topmost beds especially are distinguished by the presence of a great number of large *Ptychites*, belonging to the *Rugiferi*-group. But the rest of the fossils are distributed throughout the entire series of beds without any regularity.

Fossiliferous beds of Muschelkalk age are widely spread throughout the mesozoic belt of the Himálayas. They have been traced from Ladákh and Kashmir to Byans on the Nepalese frontier. But it is only in two districts that they have been examined more carefully,—in the classical sections of Spiti, and in the Niti area, where the section of the Shalshal cliff near Rimkin Paiar encamping ground, has been thoroughly studied by Griesbach and by our expedition in 1892. The faunas of these two areas are not quite identical.

Among the more important cephalopoda the following are peculiar to the Niti-area:—

Ceratites Vyasa, Diener.
,, *Airavata*, Diener.
,, *Ravana*, Diener.
,, *Visvakarma*, Diener.
,, *Kamadeva*, Diener.
,, *sp. ind. ex aff. C. Middendorfi.*
,, *nov. sp. ind. ex aff. C. Geminato.*
,, *Arjuna*, Diener.
,, *nov. sp. ind. ex aff. C. Wetsoni.*
Japonites Sugriva, Diener.
,, *Chandra*, Diener.
Sturia Sansovinii, E. v. Mojsisovics.
Acrochordiceras Balarama, Diener.
Meekoceras Kesava, Diener.
,, *Gangadhara*, Diener.
,, *affine*, v. Mojsisovics.
,, *Rudra*, Diener.
,, *Nalikanta*, Diener.
,, *Nanda*, Diener.
,, *Srikanta*, Diener.
Gymnites Vasantasena, Diener.
Ptychites Drona, Diener.
,, *Govinda*, Diener.
,, *Sumitra*, Diener.

Among these species, two only, it is true, *Ceratites Ravana* and *Ceratites Vyasa* are rather frequent in the Muschelkalk of the Shalshal cliff. The absence of the rest in the collections brought from Spiti ought not to be overrated, as in Spiti the Muschelkalk has never been made the object of so thorough an examination as in the Shalshal cliff, where our expedition spent a fortnight in collecting fossils in the triassic rocks. It is of greater importance, however, that a good many of the cephalopoda from Spiti have not been met with in the Muschelkalk of the Shalshal cliff. These cephalopoda are the following:—

Nautilus Spitiensis, Stoliczka.
Ceratites onustus, Oppel.
,, *truncus*, Oppel.
,, *Wetsoni*, Oppel.
,, *Dungara*, Diener.
,, *Himalayanus*, Blanford.
Ptychites Mallelianus, Stoliczka.
,, *cognatus*, Oppel.
,, *Tibetanus*, v. Mojsisovics.
,, *impletus*, Oppel.
,, *Vidura*, Diener.
,, *Mangala*, Diener.

Ptychites Sakra, Diener.
„ *Asura*, Diener.
Gymnites Lamarki, Oppel.
„ *Kirata*, Diener.
„ *Sankara*, Diener.
Proarcestes Balfouri, Oppel.
„ *bicinctus*, v. Mojsisovics.

Among these species *Ptychites cognatus*, Oppel, and *Ptychites Vidura*, Diener, are rather common in Spiti and seem indeed to be confined to this district.

There are, however, not less than 10 species, common to both areas, among them nearly all the important leading fossils of this horizon. These are:—

Ceratites Voiti, Oppel.
„ *Thuillieri*, Oppel.
Meekoceras Khanikofi, Oppel.
Gymnites Jollyanus, Oppel.
Buddhaites Rama, Diener.
Ptychites rugifer, Oppel.
„ *Gerardi*, Blanford.
„ *cochleatus*, Oppel.
„ *Everesti*, Oppel.
„ *Mahendra*, Diener.

To these forms *Gymnites Sankara*, Diener, may be added, being present in the Muschelkalk of the Bambanag cliffs in the Girthi Valley (Johár).

Two other Muschelkalk localities are distinguished by a rather peculiar fauna. One of them is the Southern slope of the Utadhura Pass (Johár), which leads from Milam to the Girthi Valley. The fauna found in these beds is composed as follows:—

Ceratites nov. sp. ex aff. C. Ravana.
„ *cf. Ravana*, Diener.
„ *Thuillieri*, Oppel.
„ *div. sp. ind.*
Acrochordiceras Joharense, Diener.
Danubites Dritarashtra, Diener.
Gymnites nov. sp. ind. ex aff. G. Sankara.
Ptychites sp. ind.
Proarcestes sp. ind.
Orthoceras cf. campanile, E. v. Mojsisovics.

The second locality is situated north of Kalapani encamping ground (Kali River Valley), in Byans, near the *triplex confinium* of Kumaon, Hundés and Nepal. At this place a good many fossils were collected by Griesbach, who mistook them for upper-triassic. All the fossils are of an obliquely elliptical shape, apparently owing to a later deformation in the matrix. This fauna is rich in individuals, though not

in species. The cephalopoda, of which there will probably be an interesting harvest, if once these beds are systematically searched, are the following :—

Nautilus Griesbachi, Diener.
Ceratites Kuvera, Diener.
Buddhaites Rama, Diener.
Ptychites Sahadeva, Diener.

This fauna decidedly shows the character of the Muschelkalk, one of the leading species in both, *Buddhaites Rama* being identical.

It is a pity that so few fossils only have been collected in the triassic rocks of Kashmir. Among the collection of the Geological Survey Museum in Calcutta, sent to Vienna, there is only one fairly preserved specimen of *Ceratites Thuillieri* from Sunamarg which points to the presence of Muschelkalk.

As far as palæontological analogies exist between the faunas of the Mediterranean and the Indian Muschelkalk, they are confined almost exclusively to such forms as are peculiar to the zone of *Ceratites trinodosus* (Upper Muschelkalk) in the Mediterranean Triassic province. This remark principally applies to the most frequent species, which ought to be considered as the real type fossils of the Himálayan Muschelkalk, *viz.*, *Ceratites Thuillieri*, Oppel, *Meekoceras Khanikofi*, Oppel, *Gymnites Jollyanus*, Oppel, etc. The species in the two zoo-geographical areas identical or almost so, namely, *Sturia Sansovinii*, v. Mojs., *Proarcestes Balfouri*, Oppel (=*Escheri* v. Mojs. ?) and *Orthoceras campanile*, v. Mojs., are found exclusively in the Upper Muschelkalk of the Alpine Trias. Only two Indian species are allied to Mediterranean forms from the zone of *Ceratites binodosus*, *viz.*, *Ceratites Wetsoni*, Oppel, is allied to *Ceratites Erasmi*, v. Mojs., and *Ptychites cochleatus*, Oppel, to *P. Studeri*, v. Hauer, whereas one single species, *Ceratites Vyasa*, is the nearest ally to *Ceratites zezianus*, v. Mojs., from the Buchensteiner Schichten, that is to say from the zone of *Protrachyceras Curionii*, which follows immediately above the *Trinodosus*-horizon.

So far as such palæontological analogies may be permissible in correlating formations geographically so widely separated, we may consider the main mass of the Himálayan Muschelkalk to be an equivalent of only the Upper Alpine Muschelkalk of the Mediterranean triassic province. The horizon of *Sibirites Prahlada* naturally belongs to a lower stage, which follows immediately above the beds with *Ceratites subrobustus* and corresponds to the Alpine Werfen-beds. Thus the evidence points to a correlation with the Lower Alpine Muschelkalk.

Although the question of the probable age of the Indian Muschelkalk-fauna seems thus to be easily solved, it becomes rather complicated, if we consider its relation to the faunas of the Himálayan groups of upper-triassic age, which follow higher up.

In the Central Himálayas of Gurhwal and Kumaon the Muschelkalk is regularly and conformably overlaid by a mighty system of limestones and shales, which has yielded cephalopoda of the Carnian and Juvavic stage. In my preliminary notes and in accordance with Griesbach's description I called this

system "*Daonella*-beds." A somewhat lower cephalopod-bearing horizon may perhaps be represented by the *Tropites*-beds of Kalapani (near the Nepalese frontier) in Byans. According to E. v. Mojsisovics[1] it corresponds approximately to the zone of *Tropites subbullatus*, but our expedition in 1892 did not succeed in finding it anywhere in the *Daonella*-beds in the Central Himálayas of Painkhánda, Johár and the adjoining parts of Hundés. I was, however, fortunate enough to trace out another upper-triassic rock-group in the section of the Shalshal cliff near Rimkin Paiar Encamping Ground. It consists of crinoid-limestones only a few metres in thickness which follow immediately above the topmost *Ptychites* beds of the Muschelkalk. The lithological demarcation from the main mass of the Muschelkalk is very slight, but its fauna is a perfectly different one. As Dr. E. von Mojsisovics tells me, it contains several species of *Trachyceras* and *Joannites*, very nearly allied, if not identical, with Alpine forms from the zone of *Trachyceras Aonoides* (Raibl-beds). Therefore it has to be considered as homotaxial with the *Aonoides*-beds of the Carnian stage.

The sequence recalls in a very remarkable manner the analogous conditions which prevail in the Reifling-and Partnach-development of the Alpine Trias and also in the Hallstatt-development of the Salzkammergut (Austria). There also follows, above the Muschelkalk, the zone of *Trachyceras Aonoides* as the next fossiliferous horizon; but the entire Norian stage and the St. Cassian-beds are either not developed at all or only represented by deposits extremely small in thickness and very poor in fossils.[2]

Nowhere in the Himálayan Trias have deposits of Norian or Lower-Carnian age been met with between the Muschelkalk and the *Daonella*-beds. In the section of the Shalshal cliff the topmost *Ptychites*-beds of the Muschelkalk are conformably overlaid by the crinoid-limestone with the *Aonoides*-fauna, the most intimate structural and lithological continuity existing between them. Thus the question arises, whether there is indeed no palæontological representation of the Norian stage in the Himálayan Trias, or whether the Muschelkalk in the Himálayas may contain also some Norian elements and in the Indian Triassic province may comprise the Norian stage together with the *Trinodosus*-horizon.

The relations which exist between the faunas of the Indian and the Mediterranean Muschelkalk are, however, not favourable to an affirmative answer to this. Among all the Cephalopoda of the Himálayan Muschelkalk one species only, *Ceratites Vyasa*, is closely allied to an Alpine form of lower Norian age. It may be noticed in support of this suggestion, that some Himálayan *Meekoceratidæ* belonging to the group of *Meekoceras Reuttense* (*M. Khanikofi*, Oppel, *M. Kesava*, etc.) are distinguished by a richer brachyphyllic ornamentation of their sutures than their Alpine allies.

[1] Vorläufige Bemerkungen über die Cephalopodenfaunen der Himálaya-Trias. Sitzgsber. Kais. Akad. d. Wiss. Wien, math. nat. cl. Bd. CI., I. Abth. p. 374.

[2] E. v. Mojsisovics, Die Hallstätter Entwicklung der Trias: Sitzgsber. Kais. Akad. d. Wiss., Wien 1892 Bd. CI. I. Abth., p. 777.

A comparison with the allied forms of the Arctic-Pacific province also offers but little support on behalf of this suggestion. In this respect the most important type is *Japonites Sugriva*, the sutures of which species are exactly of the same rather advanced type of development as those in *Japonites planiplicatus*, v. Mojs., from the geologically younger triassic beds of Japan. Among the *Ceratites circumplicati* of the *Polaris*-group, there are several species, which combine brachyphyllic sutures with a far advanced development of sculpture, as for instance *Ceratites Ravana*, *C. Voiti*, Oppel, *C. Airavata*. No further conclusions can be derived, however, from this fact, because their Arctic ancestors from the Spitzbergen Posidonomya Limestone belong to a very low horizon of the Muschelkalk.

It results from these reflections, that there is little to support the suggestion that representatives of Norian types exist in the fauna of the Indian Muschelkalk. Our present knowledge of the palæontological evidence does not justify us in considering the Himálayan Muschelkalk as a homotaxial equivalent of the Muschelkalk and of the Norian stage of the Mediterranean province. But, on the other hand, there remains the difficulty of explaining the absence, in the Indian Triassic province, of a faunistic representative of the entire Norian and lower Carnian stage between the zones of *Ceratites trinodosus* and *Trachyceras Aonoides*.

No faunistic relations are apparent between the Himálayan Muschelkalk and the triassic beds of the Salt-Range (Punjáb). Such relations are confined to the lower triassic strata of the Himálayas, as has already been noticed by Waagen and E. v. Mojsisovics. A fauna analogous to that of the Ceratite-beds in the Salt-Range is contained in the Himálayan deposits between the *Otoceras*-beds and the horizon of *Sibirites Prahlada*, distinguished by the presence of *Ceratites subrobustus*, v. Mojs., one of the leading fossils of the Siberian Olenek-beds.[1]

A very interesting Triassic fauna was discovered by L. Loczy north of the great Buddhist temple of Tchungtien in the Kingcha-kiang valley.[2] Sandstones and argillaceous shales yielded the following fossils :—

Myophoria elegans, Dunker.
„ *cf. chenopus*, Laube.
„ *cf. cardissoides*, Schloth.
Loxonema cf. subornata, Münst.
Encrinus liliiformis.

This fauna shows the greatest affinity with the German Muschelkalk, although *Myophoria cf. chenopus* and *Loxonema cf. subornata* point to the Alpine Trias.

This evidence, however, is too vague to permit conclusions to be formed on the relations which may exist between these deposits and those in the Himálayas.

[1] This subject will be further discussed in Pt. 1. of this series, which will appear later on.

[2] Die wissenschaftlichen Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien 1877-1880. Wien E. Hölzel, 1893, I. Bd., p. 738.

Part III.

THE CEPHALOPODA OF THE TRIASSIC LIMESTONE-CRAGS OF CHITICHUN.

North of the main region of the Himálayan Trias and amidst the Tibetan zone of Spiti Shales and Gieumal Sandstones, are found triassic rocks, which occur under very peculiar conditions. They appear in the neighbourhood of the Balchdhura pass (near Laptal encamping ground) and in the range of Chitichun No. I, (17,740 feet) in Hundés; they form "Klippen," detached outcrops, of the nature of the "blocs exotiques" of Switzerland, in the midst of much younger sediments and are without apparent connection with the triassic beds of the main region. Their lithological character strongly reminds one of the Hallstatt facies of rocks, and differs entirely from that of the triassic rocks of the neighbouring area.

These triassic crags which were most carefully studied by the expedition in 1892 are those situated near the peak Chitichun No. I. (17,740 feet) in the Tibetan province of Hundés. Griesbach has already published a preliminary description of the geological features of this interesting country.[1]

The main mass of the top of Chitichun No. I. consists of a white, more or less crystalline limestone, alternating with layers of red, arenaceous or earthy limestones and with lenticular intercalations of a red crinoid limestone. It forms a crag or block of 100 to 150 metres in height which seems to rest on the Spiti Shales, which constitute the base of the whole range, and are disturbed and traversed by eruptive rocks in common with the Spiti Shales. In this limestone a very rich fauna of brachiopods, corals and Bryozoa has been collected. A few remains of trilobites and ammonites have been found. Among the latter is a very well preserved specimen of a species of the genus *Popanoceras* Hyatt, which is closely allied to *Popanoceras* (*Stacheoceras*) *mediterraneum* Gemellaro, from the Permian rocks of Sicily. The trilobites are represented by two new species of the genus *Phillipsia*. Among the numerous brachiopods, the genera *Productus* (*P. semireticulatus* Mart., *P. lineatus*, W., *P. gratiosus*, W., *P. cancriniformis*, *P. Abichi* W.), *Spirifer* (*S. musakheylensis* Dav., *S. Wynnei* W.), *Enteletes*, *Marginifera* *Notothyris*, *Hemiptychina*, *Athyris*, *Martinia*, *Reticularia*, *Spiriferina*, (*S. cristata* Schloth.), *Dielasma* (D. acutangulum W.,) *Lyttonia*, *Aulosteges*, are represented. Most of the forms are identical or very closely allied to species of the middle Productus-Limestone of the Salt-Range. Although a more thorough examination of the rich material must be waited for, to form the base of an exact determination of its age, the whole character of the fauna is such a one, that it can only be a question, whether it is to be placed into the Permo-carboniferous or into the Permian.

Besides the top of Chitichun No. I., which forms a crag of undoubtedly palæo-

[1] *C. L. Griesbach*, Notes on the Central Himálayas, Records Geol. Surv. of India, Vol. XXVI, Pt. I, 1893, p. 19.

zoic age, numerous other masses of limestone rise from the Spiti-Shales and the igneous rocks associated with them, in the shape of cliffs or crags, or are imbedded in the younger strata in the shape of detached blocks. Some of these crags or blocks, which differ greatly in size, have been proved by their fossil contents to be also of palæozoic age. Two other crags to the north-east of Chitichun No. I. are probably of rhaetic or of liassic age. In three instances a triassic fauna has been met with in small detached blocks of no apparent connection with the principal mass of Chitichun No. I. These three crags were completely surrounded by Spiti-Shales and of proportionately small size.

The first find consisted of only a few blocks and is situated near the low pass west of the peak Chitichun No. I. on the route from the Kiogarh Chaldu Pass (17,440 feet) to Chitichun encamping ground. It is the same block, which is mentioned by Griesbach[1] as containing numerous, though badly preserved, ammonites in sections. As later examinations have proved, these ammonites belong to the triassic genera *Xenodiscus* and *Monophyllites*.

The second block is in a narrow ravine on the eastern slope of Chitichun No. I, to the west-north-west of Lochambelkichak encamping ground. This was discovered by Mr. Middlemiss, at some distance from the crags of Chitichun No. I., and is completely imbedded in Spiti-Shales. I am obliged to lay special stress on the fact, that this block is entirely separated from all the palæozoic blocks on the same hill-side and that no connection between them could be observed, as in a foot-note added by Dr. W. King to Griesbach's preliminary description (l. c. p. 25), it has been suggested that the cephalopoda collected by Mr. Middlemiss in these crags were found in the same beds, as the palæozoic fossils mentioned by Griesbach from the main mass of the Chitichun limestone. It may be stated once more, that the fauna of this small crag is entirely different from that of the top mass of Chitichun No. I., that not one single form is identical in the two, and that the crags themselves are separated by the crushed and disturbed beds of the Spiti-Shales which surround Mr. Middlemiss' crag on every side and impart to it the character of a detached block. Mr. Middlemiss' crag consists of only a small number of blocks, of a red or red and white coloured limestone, with but very little admixture of argillaceous material. Occasional layers of a red crinoid limestone are seen to be intercalated. It is especially this latter, which contains many cephalopoda, gastropods and bivalves. Among the gastropods and bivalves only very small forms are found. Among the cephalopoda species of rather small size prevail, although large ones are not totally absent. The state of preservation of the specimens is as a rule an excellent one. Whereas in the region of the normal development of the Himálayan Trias individuals with preserved shell are but exceptionally met with,—in the upper-triassic deposits this is even much more the case than in the Muschelkalk,—they are very common in the triassic deposits of this locality. Complete specimens, however, are rather rare, and some blocks consist almost entirely of crushed shells only.

I discovered a third triassic crag north of Lochambelkichak encamping ground,

[1] l. c. p. 23.

and near the pass which leads into the valley of the Chaldu River. It also contains several blocks formed of *lumachellæ* of *Xenodiscus* and *Monophyllites*.

The cephalopoda, described in the following pages, have been collected, almost without exception, at the second of the three above-mentioned localities (west-north-west of Lochambelkichak encamping ground). The fossiliferous blocks of this small crag have been almost completely cleared of their fossil remains by Mr. Middlemiss and myself during our repeated excursions.

In the following pages I describe the cephalopoda of this collection:—

I. AMMONEA.

A. AMMONEA TRACHYOSTRACA.

Family: *CERATITIDÆ.*

Sub-family: DINARITINÆ.

Sub-genus: DANUBITES, E. v. Mojsisovics.

1. Danubites Kansa nov. sp. Pl. XXIX., fig. 1.

Dimensions.

Diameter of the shell	89 mm.
Height of the outer whorl	33 „
Thickness of the „ „	27 „
Diameter of the umbilicus	39 „

In the fauna of the triassic crags of Chitichun the sub-genus *Danubites* is represented by two typical forms, distinguished by slowly increasing, but very slightly overlapping volutions, by simple, straight ribs, confined to the lateral parts, and the absence of any sculpture in the siphonal area.

One of these two forms, *D. Kansa*, has a remarkable resemblance to *D. Naumanni*, E. v. Mojs., from the Trias of Japan.[1] The general shape of these two species is almost identical; the umbilical suture passes inside the siphonal saddle of the next inner whorl. The whorls are higher than thick, and have moderately convex sides, which pass gradually into the rounded umbilical margin and into the likewise rounded siphonal area.

The lateral parts are covered with numerous, single, radial ribs, which become obsolete both towards the umbilical margin and the siphonal area. None of the ribs reach the umbilical suture. The sculpture does not correspond on both sides and is completely interrupted on the siphonal side, which remains smooth. Ribs and intercostal depressions are of nearly equal width, as in *D. Naumanni*. The number of ribs which occur on the last, entirely chambered volution, is 39 (whereas there are about 50 in *D. Naumanni*).

Sutures.—The septa are very distant, as in *D. Naumanni* or in the Mediterranean group of *D. floriani*, v. Mojs. The arrangement of the lobe-line likewise reminds of *D. Naumanni*. The lobes are deep and comparatively narrow, the

[1] Ueber einige japanische Triasfossilien, Beiträge zur Palæontologie Oesterreich-Ungarns und des Orients, herausgegeben von E. v. Mojsisovics und M. Neumayr, Vol. VII. Wien 1888, Taf. II, fig. 1, p. 169.

saddles are high and slender. Slightly incised indentations affect the marginal walls of the principal saddles up to the middle of their height. The upper portion of the saddles is entire. In this respect the two species are in almost the same stage of development.

The lobes are provided with deep, strong digitations at their base. The principal lateral lobe is the deepest and contrasts remarkably with the extremely short siphonal lobe, divided by a low siphonal tubercle. One bifid auxiliary lobe outside the umbilical suture. The principal lateral saddle is higher than the siphonal saddle, whereas exactly the reverse is the case in *D. Naumanni*.

Number of specimens examined.—One.

2. Danubites Ambika nov. sp. Pl. XXIX., fig. 2.

Dimensions.

Diameter of the shell	43 mm.
Height of the outer whorl	15 „
Thickness of the „ „	14·5 „
Diameter of the umbilicus	18 „

This species is represented by only a single specimen, entirely chambered. It differs from *Danubites Kansa* in its general shape by more slowly increasing and also thicker volutions, and a more flatly curved siphonal area. The latter is separated from the comparatively flat lateral parts by a rounded edge. A low but perpendicular inner wall borders the rounded umbilical margin.

The character of sculpture is identical with that of the last-mentioned species. In one-half of the penultimate whorl about 20 ribs may be counted. The ribs broaden out towards the siphonal margin, and there gradually disappear.

In the inner volutions several transitional margins of apertures are visible They intersect the ribs in the form of a sweeping curve well turned backwards which is followed by a forward-turned, small process near the umbilical margin.

Sutures.—The sutural line differs remarkably from that in *D. Kansa* and recalls much more the sutures peculiar to the Mediterranean group of *D. floriani*. The contrast between the high, elongated, siphonal saddle and the low, flat lateral saddles is most striking. Two broad lateral lobes, provided with sharply pointed, proportionately strong indentations at their base. The principal lateral lobe is the deepest. The short, broad siphonal lobe is serrated at its base. In the outer volution when reaching a height of 35mm. the first auxiliary lobe appears outside the umbilical suture.

Number of specimens examined.—One.

Family: *TROPITIDÆ*

Genus: SIBIRITES E. v. Mojsisovics.

Sibirites Pandya nov. sp. Pl. XXIX., fig. 3.

Dimensions.

Diameter of the shell	27 mm.
Height of the outer whorl	10 „
Thickness of the „ „	9 „
Diameter of the umbilicus	12 „

The close relationship of this interesting species, to the genus *Sibirites*, v. Mojs., is proved by its very characteristic sculpture and arrangement of the sutures, in spite of some considerable differences which exist between it and the congeneric forms, hitherto described from the Mediterranean and Arctic-Pacific provinces.

The slowly involute whorls overlap each other down to the bifurcation of the ribs and enclose a tolerably wide, stairlike umbilicus. In the inner volutions the umbilical margin is rounded and not well defined from the sides, as is the case in the outer whorl. In the body-chamber the siphonal part is likewise distinctly separated from the sides. The shape of the transverse section is therefore almost circular in the inner volutions, but becomes gradually rectangular near the posterior termination of the body-chamber. The siphonal area however remains well rounded even in the anterior termination of the last whorl, although the lateral parts flatten considerably.

The sculpture consists of numerous, coarse, radial ribs. But very few of them cross the siphonal area without bifurcating. In most of them a bifurcation takes place near the siphonal margin. The two new ribs, originating at the bifurcation of one single lateral rib, are considerably weaker and narrower than the original. They cross the siphonal area as one straight, and uninterrupted line as in the geologically younger forms from the upper triassic beds of the Alps or of the Himálayas. Also the ribs, which remain undivided, become very faint in crossing the siphonal area, the sculpture of which is therefore distinctly separated from that of the lateral parts. In some ribs a slight prominence is formed at the point of bifurcation, but it does not develop into a distinctly defined tubercle.

The whorls overlap each other exactly down to the bifurcation of the ribs, and in the inner volutions only the simple, radial sculpture is visible. In the last volution, two-thirds of which belongs to the body-chamber, there are 28 radial ribs.

In the penultimate whorl two transitional mouth-borders are seen. In these mouth-borders one large backward-turned convexity coincides with the middle portion of the sides, whereas in the umbilical and siphonal margins their direction, which differs from the normal sculpture, is curved forward.

Sutures.—The arrangement of the sutural line is the same as in the congeneric species from the Arctic-Pacific province. The siphonal lobe terminates in two points and is divided by a short siphonal tubercle. It stands only a little higher than the principal lateral lobe. The latter is provided with distinct indentations which may even be noticed without the help of a magnifying glass. It coincides with the bifurcation of the ribs. The second lateral lobe is at the same level as the siphonal lobe and a little outside the rounded umbilical margin. The principal lateral saddle is comparatively high and slender and resembles the siphonal saddle in this respect. The two saddles are perfectly entire. The second lateral saddle is broad and flat.

There are only two lateral but no auxiliary lobes. The figure (fig. 3c.) must

be corrected in this respect, as the second lateral saddle reaches to the umbilical sutures, without the intervention of any further lobe.

Number of specimens examined.—One.

B.—AMMONEA LEIOSTRACA.

Family: *PINNACOCERATIDÆ.*

Sub-family: LYTOCERATINÆ.

Genus: MONOPHYLLITES E. v. Mojsisovics.

This genus plays a considerable part in the Trias of Chitichun, but it has as yet not been found in the Himálayan Muschelkalk of the main region. There are altogether six species in the collection from this locality. Three of them belong to the European group of *Monophyllites Suessi* v. Mojs., whilst an equal number are forms of the group of *Monophyllites sphærophyllus* v. Hauer.

Group of MONOPHYLLITES SUESSI v. Mojs.[1]

1. MONOPHYLLITES PRADYUMNA nov. sp. Pl. XXXI, fig. 3, 4.

Dimensions.	I. (fig. 3).	II. (fig. 4).
Diameter of the shell	42 mm.	26 mm.
Height of the outer whorl	13·5 „	9 „
Thickness of the „ „	10 „	9 „
Diameter of the umbilicus	21 „	12 „

This species may be looked upon as the type of the Indian representatives of the Mediterranean group of *M. Suessi* v. Mojs., to which form it is closely allied, but distinguished from it by its smooth shell and its comparatively simple sutures.

It is quite as evolute as the European species and overlaps not more than the siphonal part of the preceding whorl. Corresponding to a diameter of 30 mm., the outer whorl is of equal height and thickness, but in later stages of growth the height of the volution increases more rapidly. The siphonal area and the umbilical margin are evenly rounded and pass gradually into the sides.

The surface of the shell is almost smooth and exhibits as a rule only very delicate striæ of growth near the umbilical margin. These striæ are not nearly so well and distinctly shown as in the group of *M. sphaerophyllus.*

In some specimens, periodical exterior fimbriæ have been noticed. They are in the shape of prominent fringed ribs as in the genus *Lytoceras*, and occur more frequently in the two outer whorls at certain intervals whilst they are rarer in the inner volutions. The specimen, figured Pl. XXXI, fig. 3, possesses 3 of these narrow, radially directed fimbriæ in the last, and 4 in the penultimate volution. The fimbriæ are most prominent near the siphonal margin, where they are bordered on each side by a sharp edge.

[1] *E. v. Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz, Abh. k.k. Geol. Reichsanst. Pl. LXXIX, fig. 4, p. 205.

Sutures.—The sutures are very similar to those of *M. Suessi*, but differ in having a distinctly developed third lateral lobe. They are in a still lower stage of development than in *M. Suessi*, which represents the simplest type of the genus hitherto known in the Mediterranean triassic province. The monophyllic saddles are narrow, entire and enlarged above. At the base of the siphonal saddle as well as of the principal lateral saddle is a single and very small indentation. The two first lateral lobes are each provided with three simple indentations at their base. The siphonal lobe is almost as deep as the principal lateral one.

In the specimen figured Pl. XXXI, fig. 3, nearly one-half of the last volution forms part of the body-chamber.

Number of specimens examined—Six.

MONOPHYLLITES CONFUCII, nov. sp. Pl. XXX, fig. 7, Pl. XXXI, fig. 1, 2.

Dimensions.

	I. (Pl. XXX. f. 7).	II. (Pl. XXXI. f. 2).
Diameter of the shell	54 mm.	23 mm.
Height of the outer whorl	13 „	6 „
Thickness of the „ „	9 „	5 „
Diameter of the umbilicus	30 „	14 „

This is by far the most common species among the Indian *Monophyllites*. From *M. Suessi* and *M. Pradyumna* it differs principally by its much more slowly increasing volutions. Already *M. Suessi* is very different in this respect from all the other congeneric species of the Mediterranean Trias, but remains still far behind the present form. The specimen figured in Pl. XXXI, fig. 2, has nine volutions besides the clearly marked embryonal cell, corresponding to a diameter of 23 mm., whereas in a specimen of *M. Suessi*, with a diameter of 28 mm., E. v. Mojsisovics counted seven volutions only.

The whorls are rather compressed, higher than broad and overlap only the siphonal part of the preceding volution. The sides are flatly curved and gradually pass into the highly rounded siphonal area. The umbilical margin is rounded, the shell perfectly smooth.

Neither fimbriæ nor varices (interior laminae of the shell) have been noticed in any of the specimens.

The figured specimens are entirely chambered.

Sutures.—Almost identical with those of *M. Pradyumna*. Three lateral lobes. Only at the base of the siphonal saddle one small indentation on each side. The siphonal lobe terminates in two deep points and is divided by a high siphonal tubercle.

Number of specimens examined.—Twenty-one.

3. MONOPHYLLITES PITAMAHA nov. sp. Pl. XXXI, fig. 5, 7, 8.

Dimensions.

Diameter of the shell	55 mm.
Height of the outer whorl	17 „
Thickness of the „ „	8·5 „
Diameter of the umbilicus	24 „

This species is closely allied to *M. Pradyumna* as regards involution, but differs from it by very flat, compressed and high whorls, and also by showing some traces of transverse folds on the outer volutions. These broad, flat folds cover the lower portion of the sides only, and are slightly curved backwards. They vary much in strength and appear at different stages of growth in different individuals. In the figured specimen fig. 7, the two sides of the shell are even perfectly asymmetrical and their sculpture is completely different.

The two figured specimens are entirely chambered.

Sutures.—Almost identical with those of *M. Pradyumna.* The monophyllic shape of the saddles is especially well marked in the siphonal saddle which is provided at its base with a short indentation on each side.

Number of specimens examined.—Seven.

B. Group of MONOPHYLLITES SPHÆROPHYLLUS, v. Hauer.

4. (1) Monophyllites Hara nov. sp. Pl. XXXI., fig. 9.

Dimensions.

Diameter of the shell	51 mm.
Height of the outer whorl	21 „
Thickness of the „ „	16 „
Diameter of the umbilicus	18 „

This species is very closely allied to the Mediterranean *M. sphærophyllus*, v. Hauer,[1] not only in general shape, but also in involution and sculpture. But the shape of serration of the sutural line constitutes an essential difference. This is still simpler in the Indian form than in *M. sphærophyllus*, which may be considered to be the oldest hitherto known member of a group of forms which continue through the whole of the Mediterranean Trias, from the Muschelkalk to the zone of *Trachyceras Aonoides.*

The high, compressed whorls, which overlap the siphonal area only, have very flatly curved lateral parts and a moderately rounded siphonal area, which is distinctly separated from the sides by a steeply rounded siphonal edge. The umbilical margin slopes suddenly towards the perpendicular umbilical wall. The umbilicus is deep and stair-like.

The lateral parts are covered with numerous, narrow, faintly marked radial folds, which pass across the siphonal area, although considerably weakened. They are not merely confined to the *ostracum* of the shell like the numerous delicate, transverse striæ of growth, but may be noticed also on the surface of the cast. The shell being but partly preserved in the outer volutions of this specimen, the direction of these very densely crowded striæ of growth has not been ascertained completely. A decided forward-bent curve in the siphonal area, as in *M. sphærophyllus*,

[1] *E. v. Mojsisovics*, Die Cephalopoden der Mediterranen Triasprovinz Taf. LXXIX, fig. 1-3, p. 206.

is not visible. On the contrary, they pass radially across the sides and across the siphonal area and parallel to the faint transverse plications.

Both specimens are entirely chambered.

Sutures.—Differ from the sutures of *M. sphærophyllus* by a less rich ornamentation principally and by the absence of a third lateral saddle. The third lateral lobe is in the position of a large much drawn-out umbilical lobe. The narrow, bifid siphonal lobe is divided by a high siphonal tubercle. The principal lateral lobe is much deeper. The denticulations on the outer margins of the two principal lateral lobes, adjoining the base of the preceding saddles, are considerably less individualised than in *M. sphærophyllus.* The saddles themselves are consequently less slender and less deeply laced at their base. The serration of the base of the principal lateral lobe is identical in both species. The siphonal saddle terminates in one broad, circular foliation. The principal lateral saddle is higher, the second lower than the siphonal saddle. Both form long drawn-out foliations rounded above.

Number of specimens examined.—Two.

Remarks.—An undescribed species from the Russian Island (Eastern Siberia) is very closely allied to *M. Hara* as regards the development of its sutural line. It belongs to a collection of triassic cephalopoda from Eastern Siberia which Oberbergrath E. v. Mojsisovics has entrusted to me for description. This Siberian *Monophyllites* has also two lateral saddles only, and the third lateral lobe assumes the shape of an umbilical lobe, which cannot be divided any further.

5. (2) MONOPHYLLITES KINGI nov sp. Pl. XXXI, fig. 10.

Dimensions.

Diameter of the shell	57 mm.
Height of the outer whorl	21 „
Thickness of the „ „	13 „
Diameter of the umbilicus	22 „
Height of the whorl in the place of its greatest aplanation	16 „
Thickness of the whorl in the place of its „ „	11 „
Corresponding diameter of the shell	43 „
Corresponding diameter of the umbilicus	17 „

This form is very closely allied to *M. Hara*, but differs therefrom by its obliquely elliptical outline, by more compressed whorls, and by a narrow, high but rounded siphonal area. The latter gradually passes into the flatly curved lateral parts. The umbilicus is shallower than in *M. Hara.*

Sculpture and sutures are almost perfectly identical in the two species.

This type is represented by a single specimen, one half of the outer whorl of which is part of the body-chamber.

6. (3) MONOPHYLLITES NOV. SP. IND. Pl. XXXI. fig. 6.

The figured fragment belongs to a species, which is probably closely allied to *M. Hara* but is distinguished by its sutures, which exhibit a more advanced stage

of development. The two first lateral saddles are more slender, remarkably contracted at their base, and provided, each one, with a distinct indentation on their inner margins. The fragmentary state of the specimen did not reveal the presence of a third lateral saddle.

Part of the shell is preserved in the siphonal area. As it is covered with numerous densely crowded and very delicate lines of growth, it seems beyond doubt that this fragment belongs to the group of *Monophyllites sphærophyllus*. The fragmentary inner volution is covered with numerous, faint, radial plications.

Sub-family PTYCHITINÆ.

Genus: XENODISCUS, Waagen.

The genus *Xenodiscus*, distinguished from *Gyronites* Waagen (synonymous with *Ophiceras*, Griesbach) by its long body-chamber, has two representatives in the fauna of the triassic limestones of Chitichun. Both belong to a much more advanced stage of development, than all hitherto known forms of this genus from the Indian and Arctic-Pacific provinces. One of them is distinguished by ceratitic sutures, in which the marginal walls of the saddles are serrated up to the middle of their height, whereas in the congeneric species of the Himálayan Lower Trias the lobes are denticulated only at their base. The second species, of which unfortunately only a fragment has been found, recalls the genus *Gymnites* in the character of its sculpture.

1. Xenodiscus Middlemissi nov. sp. Pl. XXX, fig. 6.

Dimensions.

Diameter of the shell	55 mm
Height of the outer whorl	18 „
Thickness of the „ „	8 „
Diameter of the umbilicus	24 „

This species has a very flat, discoidal shell, with numerous, slowly increasing whorls. In this respect it can only be compared among the congeneric species of the lower Trias, with *Xenodiscus demissus* Oppel.[1] But it differs therefrom by more compressed volutions and by higher whorls. All the rest of the Indian or Siberian species of *Xenodiscus* are characterised by more rapidly increasing volutions.

The lateral parts are flat and aplanate. The narrow, rounded siphonal area is more or less distinctly separated from the sides by an obtuse edge. The sides slope flatly convex to the shallow umbilicus.

Surface of the shell smooth, partly interrupted by very faint and indistinct radial plications.

[1] Palæontologische Mittheil. I. 1865, Pl. 86, fig. 1, p. 290. It is, however, doubtful, whether this species may be included in the genus *Xenodiscus*.

In this specimen one-third of the last whorl belongs to the body-chamber.

Sutures.—The vertical projection of the outline of the penultimate whorl meets the inner margin of the second lateral saddle of the succeeding volution. Siphonal lobe short, only half as deep as the principal lateral lobe, and provided with a high siphonal tubercle. Lobes and saddles comparatively narrow and elongated. The second lateral saddle is very low. Lobes provided with deep digitations, which affect the marginal walls of the saddles up to the middle of their height; they are especially well developed at the inner margins of the siphonal and of the principal lateral saddles. Second lateral saddle followed by a long, serrated umbilical lobe, with two deep points near the inner margin of the saddles on both sides.

Number of specimens examined.—One.

2. Xenodiscus nov. sp. ind. Pl. XXX., fig. 4.

The fragment,—body-chamber and part of the penultimate whorl—belongs to a highly interesting form, the sculpture of which corresponds to that peculiar to the genus *Gymnites*, which is most probably descended from *Xenodiscus*. The only species of *Xenodiscus* with a similar sculpture, *X. dentosus* E. v. Mojs.[1] has long tubercles, spirally protracted and arranged along the sharply edged siphonal margin, corresponding to an equal number of faint, broad radial plications, which completely die out near the umbilical margin. But whereas in *Gymnites* this sculpture is as a rule confined to the lower portion of the sides, in *X. dentosus* the lower part of the sides is smooth and the sculpture most distinct between the middle of the lateral parts and the siphonal margin.

In this fragment, however, the sculpture agrees almost perfectly with that of *Gymnites Jollyanus* Oppel. Faint, broad, radial plications, which are bent somewhat backward, appear along the middle of the sides in the shape of prominences, arranged along an elevated spiral line. The transverse plications are interrupted by shallow, rounded depressions and become obsolete before reaching the umbilical margin, whereas the spiral elevation is continuous, or ridge-like.

The surface of the shell is covered with strongly developed lines of growth, which become indistinct in the upper portion of the sides, where they describe a slight, falciform curve.

This form, like *X. Middlemissi*, is characterised by rather slowly increasing volutions, and by a wide and open umbilicus. The whorls are compressed and high. To a height of the aperture of 35 mm. corresponds a thickness of 15 mm. The sides are flatly convex and pass gradually into the rounded siphonal area. The greatest thickness of the outer whorl coincides with the middle of the lateral parts. The umbilical margin is marked by an obtuse edge and separated from the umbilical suture by a low, perpendicular inner wall.

Sutures.—The rather unfavourable state of preservation permits only a generic

[1] Arktische Triasfaunen; Mém. Acad. Imp. des Sc. de St. Pétersbourg VII[e] sér. Vol. XXXIII, 1886. Pl. XI. fig. 12, p. 78.

identification. The siphonal saddle is remarkably large. The second lateral saddle is nearly as high as the principal one. The lobes are broad and, so far as can be ascertained, provided with deep digitations at their base. There seems to be only one single auxiliary lobe.

Number of specimens examined.—One.

Genus GYMNITES. E.v. Mojsisovics.

GYMNITES UGRA nov. sp. Pl. XXX., fig. 5.

Dimensions.

Diameter of the shell	60 mm.
Height of the outer whorl	24 „
Thickness of the „ „	12 „
Diameter of the umbilicus	23 „

This species is one of the most interesting forms in the small fauna of the Triassic limestones of Chitichun, because it represents the oldest type hitherto known of the genus *Gymnites*, the sutural line of which is still in a very low stage of development and has only just passed from the *Xenodiscus*-stage into that of *Gymnites*.

It recalls in general shape and involution *Gymnites incultus* Beyrich[1] among the European, and of *G. Vasantasena* among the Indian congeneric species. The numerous, slowly increasing volutions, which overlap each other to one half of their height, are compressed and bordered by almost flat lateral parts. The narrow and rounded siphonal area passes gradually into the sides. An obtuse edge marks the umbilical margin, from which a short but steep inner wall slopes towards the umbilical suture.

The sculpture consists on the inner volutions of broad, transverse plications, which are almost as broad as the intervening depressions; they are narrower and less distinctly shown on the last whorl. Along the centre of the sides, a series of tubercular prominences,—the terminations of the folds,—appear as a chain or raised band.

Sutures.—In the figured specimen, which consists almost entirely of air-chambers, the vertical projection of the outline of the penultimate volution touches the inner margin of the second lateral saddle. The short siphonal lobe is divided by a broad pyramidal siphonal tubercle, the height of which nearly equals that of the siphonal saddle. The principal lateral lobe is the deepest.

The ramification of the lobes and saddles is not so far advanced as in the young individuals of G. *incultus*, figured by E. v. Mojsisovics.[2] The saddles are dolichophyllic, and at the top of the siphonal saddle a deeper incised, rounded branch starts from the outer margin. This is the only trace of a more advanced ramification in the broad saddles. The lobes are provided with deep digitations at their base, which, however, are simpler than in the young specimens of *G. incultus*. In

[1] E. v. Mojsisovics, Die Cephalopoden der Mediterranen Trias-Provinz: Abh. k.k. Geol. Reichsanst, Vol. X, Pl. LIV, fig. 1—3, p. 233.

[2] l. c. Taf. LIV, fig. 3c.

the latter, every single digitation is already denticulated, when corresponding to a height of the outer whorl of 9 mm.

The arrangement of the auxiliary lobes is very characteristic. The second lateral saddle is perfectly individualised and followed by a deep incision, which marks the first auxiliary lobe. The two next larger branches slope obliquely towards the umbilical suture. These two auxiliary saddles are entire. The broad sutural lobe which follows is serrated but does not permit tracing out its further elements. These well-individualised obliquely-shaped auxiliary lobes differ from the more simple sutures of *Xenodiscus* and justify the determination of this species as *Gymnites*, in spite of the simpler development of the other sutural elements.

Number of specimens examined.—Two.

Genus STURIA E.v. Mojsisovics.

Sturia mongolica nov. sp. Pl. XXIX., fig. 4.

Dimensions.

Diameter of the shell	69 mm.
Height of the outer whorl	37 „
Thickness of the „ „	21 „
Diameter of the umbilicus	8 „

This species, which does not seem to show any relationship to any of the Mediterranean congeneric forms, differs from the latter by a comparatively wide, open umbilicus, and by simpler sutures.

The volutions exhibit considerable egression and are separated from the umbilicus by a high and perpendicular umbilical wall. The umbilical margin is a sharp edge, already distinctly marked in the inner volutions.

The lateral parts are moderately convex. Siphonal area narrow, rounded, and passing gradually into the sides. The outer whorl is thicker than in most of the congeneric species from the Alpine Muschelkalk. As in *Sturia semiarata* E. v. Mojs.,[1] flat radial folds are strongly developed on the surface of the lateral parts, especially on their lower portion.

In the only specimen of this form in my collection the shell is but partly preserved and I am therefore not quite satisfied about the sculpture on its surface. On the outer volution the siphonal striations have been observed; they are numerous, thin and bordered by a sharp edge, as in *S. Sansovinii*, E. v. Mojs.

Sutures.—The sutures of this specimen, which is entirely chambered, typically exhibit the shape and arrangement of the sutures peculiar to the genus *Sturia*. The vertical projection of the outline of the penultimate whorl touches the inner margin of the second lateral saddle. Five auxiliary lobes outside the umbilical edge. The broad siphonal tubercle, stretching from the siphonal area over the lateral parts, is only half as high as the siphonal saddle. The latter stands at equal height with the second lateral saddle. The two lateral lobes are considerably longer than the

[1] Die Cephalopoden der Mediterranen Triasprovinz: Abh. Geol. Reichs-Anst. Vol. X, Pl. XLVIII. fig. 8; Pl. XLIX, fig. 1, 3; Pl. L, fig. 2, p. 242.

siphonal lobe. Their termination is bifid. The pyramid-shaped saddles are very slender, their branches being incised so deeply, that only the very stems remain entire. The ornamentation of the branches is, however, not nearly so rich as in *S. semiarata*, *S. Sansovinii* or *S. forojuliensis*. In the siphonal saddle the strong outer branch, peculiar to the two first-mentioned species, is missing. Altogether the sutures of *S. mongolica* may be said to be on a somewhat lower level of development than the Mediterranean representatives of this genus in the Alpine Muschelkalk.

Number of specimens examined.—One.

Family: *ARCESTIDÆ.*

Sub-family: JOANNITINÆ.

Genus: PROCLADISCITES E. v. Mojsisovics.

This genus was hitherto only known from the Upper Muschelkalk and from the zone of ***Protrachyceras Archelaus*** in the Mediterranean Triassic province, but is represented in the triassic fauna of Chitichun by a form which is very closely allied to the European species of ***Procladiscites Brancoi***, E. v. Mojs.

PROCLADISCITES YASODA nov. sp. Pl. XXX. fig. 1, 2, 3.

Dimensions.

Diameter of the shell	60	mm.
Height of the outer whorl	32	„
Thickness of the „ „	14	„
Diameter of the umbilicus	8	„

This handsome species is evidently closely related to *P. Brancoi* E. v. Mojs.[1] from the Upper Muschelkalk of the Alpine Trias (zone of *Ceratites trinodosus*). The agreement between the two species is remarkable not only in involution, but also in sculpture and arrangement of the sutural line.

P. Yasoda has as high and compressed whorls as its European ally; a narrow rounded siphonal area and flat lateral parts, which pass gradually into the siphonal area. An essential difference from *P. Brancoi* consists in the shape of the umbilicus. As E. v. Mojsisovics has remarked, the shape of the umbilicus in *P. Brancoi* is not accurately known. "There seems to have existed a narrow, open umbilicus; it may however, be possible, though not probable, that the umbilicus was closed, as in the greater number of the species of *Cladiscites*." But *P. Yasoda* has a comparatively wide open umbilicus, which exposes the numerous inner volutions as narrow, spiral-bands. In the young specimen, figured Pl. XXX., fig. 2, to a diameter of the shell of 26mm. corresponds an umbilicus of 4mm. In this respect this species recalls *P. macilentus*[2] from the Muschelkalk of Han Bulog in Bosnia.

[1] Abh. kk. Geol. Reichsanst. Vol. X. Pl. XLVIII. fig. 1, 3, p. 171.

[2] F. v. Hauer, Beiträge zur Kenntniss der Cephalopoden der Trias von Bosnien. I. Neue Funde aus dem Muschelkalk von Han Bulog bei Sarajevo: Denkschr. Kais. Akad. d. Wiss. Wien, math. nat. Cl. LIX. 1892, Taf. X. fig. 2, p. 280.

The sculpture of the shell agrees perfectly with that of *P. Brancoi.* The numerous and thin spiral ribs are somewhat narrower than the intervening depressions.

Sutures.—Very similar to the sutures of *P. Brancoi.* Three lateral lobes. The second lateral lobe is the deepest. Siphonal lobe short, although rather deeper than in the European species. Siphonal saddle lower than the two first lateral saddles. All terminate in one single rounded lapel growing narrower towards the top. The number of auxiliary lobes cannot be ascertained, but is probably less than in *P. Brancoi.* The ornamentation of the lobes and of the branches of the saddles is simpler in the details.

In the specimen figured Pl. XXX. fig. 3, one half of the outer volution belongs to the body-chamber.

Number of specimens examined.—Ten.

II. NAUTILEA.

Family: ORTHOCERATIDÆ.

Genus: ORTHOCERAS, Breynius.

ORTHOCERAS sp. ind. Pl. XXIX., fig. 5.

This figure refers to a fragment of a body-chamber 95 mm. long and points to a form which was distinguished by a long body-chamber and by a circular transverse section. The diameter of the body-chamber is 15·5 mm. at its posterior termination and 20 mm. at its anterior margin where broken off. Angle of emergency about 4°.

The shell is smooth. In the upper portion of the cast the existence of a flat transverse band is noticed.

The central position of the siphuncle, as drawn in the figure (fig. 5b), is rather doubtful.

Number of specimens examined.—Two.

CONCLUSIONS.

The fauna of cephalopoda from the Triassic limestone of Chitichun contains the following species .—

1. *Danubites Kansa*, Diener.
2. „ *Ambika*, Diener.
3. *Sibirites Pandya*, Diener.
4. *Monophyllites Pradyumna*, Diener.
5. „ *Confucii*, Diener.
6. „ *Pitamaha*, Diener.
7. „ *Hara*, Diener.
8. „ *Kingi*, Diener.
9. „ *nov. sp. ind.*
10. *Procladiscites Yasoda*, Diener.
11. *Xenodiscus Middlemissi*, Diener.
12. „ *nov. sp. ind.*
13. *Gymnites Ugra*, Diener.
14. *Sturia mongolica*, Diener.
15. *Orthoceras sp. ind.*

The genera which are represented in this fauna may be divided into three groups.

The first group is represented by the genus *Xenodiscus*, which has hitherto only been found in younger palæozoic or in lower triassic strata. The second group comprises the genera *Monophyllites*, *Procladiscites*, *Gymnites* and *Sturia*, none of which have ever been found in a lower horizon of the Mediterranean Trias than in the Muschelkalk. To the third group belong *Danubites* and *Sibirites*, which make their first appearance in lower triassic or even in Permian(?) beds, but ascend into upper triassic horizons.

The most important feature of this triassic fauna are the genera of the second group. So far as numbers go, the genus *Monophyllites* and among that the species allied to *M. Suessi*, v. Mojs., play the principal part. The sutures of the Himálayan forms belonging to this section are on a somewhat lower level of development, than in *M. Suessi*, the simplest type of this genus in the Mediterranean province. In *M. Hara* and in *M. Kingi*, belonging to the group of *M. sphærophyllus*, v. Hauer, the ornamentation of the sutures is likewise far less advanced than in their European ally from the Alpine Muschelkalk. Only the *Monophyllites* figured in Pl. XXXI, fig. 6, which is unfortunately in a rather fragmentary state of preservation, has a sutural line of similar development to *M. sphærophyllus*.

There are similar relations between *Sturia mongolica* and the congeneric species of the Mediterranean Triassic province, as between the above-mentioned Indian *Monophyllites* and their European allies. In *S. mongolica* the sutures are also of a somewhat lower character of development than in the geologically oldest congeneric forms from the upper Alpine Muschelkalk. But it is distinguished from the latter by a wide, open umbilicus and the egression of the outer volution.

The antique character of the Indian representatives of the genera peculiar to the Muschelkalk in the Mediterranean Triassic province is still more clearly shown in *Gymnites Ugra*, the sutures of which have only just completed the transition from the *Xenodiscus*—into the *Gymnites*-stage.

The most advanced faunistic element among the triassic cephalopoda of Chitichun is *Procladiscites Yasoda*, which is very closely allied to the Mediterranean *P. Brancoi*, v. Mojs. from the Upper Alpine Muschelkalk, differing therefrom only in quite subordinate details of the sutural line.

The genus *Sibirites*, and especially *Sibirites Pandya*, does not afford any clue to the age of the triassic fauna of Chitichun. The existence of *Danubites Kansa* however, which is closely allied to the Japanese *D. Naumanni* v. Mojs., is evidence decidedly in favour of a younger horizon than Lower Trias. Forms of *Danubites* with such highly develop ed sutures, the marginal walls of their saddles even being partly provided with indentations, have never been collected hitherto, either in the Olenek-beds of Siberia, nor in the lower Trias of the Himálayas.

The genus *Xenodiscus*, it is true, has hitherto only been met with in the Permian rocks of the Salt Range, in the lower Trias of the Himálayas, in the Siberian Olenek-beds and in the homataxial Meekoceras-beds of Idaho in the United States of North America. In the Mediterranean Muschelkalk its place is taken by the genus *Gymnites*, most probably descended from *Xenodiscus* as has been pointed out by v. Mojsisovics. In the Muschelkalk of the main region of the Himálayas, *Xenodiscus* is likewise missing, and the forms of *Gymnites* peculiar to this horizon are all distinguished by richly ramified sutures. It ought however to be taken into consideration, that the fauna of the Muschelkalk of the Central Himálayas contains almost exclusively such types of cephalopoda only as are peculiar to the upper Mediterranean Muschelkalk, whereas the lower portion of the Himálayan Muschelkalk is represented by a fauna rich in brachiopods and bivalves, from which as yet only one single ammonite, *Sibirites Prahlada* is known. It must, moreover, be borne in mind, that the two species of *Xenodiscus* belonging to the triassic fauna of Chitichun, point to a far more advanced stage of development than any of the congeneric forms from the lower Trias. This not only refers to *Xenodiscus Middlemissi*, the ceratitic lobes of which are serrated up to the middle of the marginal walls of their saddles, but also to the second but indifferently preserved species, which is distinguished by a perfectly "*Gymnitic*" sculpture.

Judging by its general zoological character, the fauna of the triassic limestone of Chitichun can only be looked upon as a Muschelkalk fauna. The presence of the genus *Xenodiscus*, otherwise confined to lower triassic beds, but associated with a far greater number of types peculiar to the Muschelkalk, cannot influence this decision and so much the less, since together with *Xenodiscus* the oldest hitherto known representative of the geologically younger genus *Gymnites* makes its first appearance.

The Muschelkalk types, which are in predominating numbers, are all of a development, which points to a lower horizon than that of the Muschelkalk of the main region of the Central Himálayas. This view is especially confirmed by the

character of the *Monophyllites*, of *Sturia mongolica* and of *Gymnites Ugra*, which impart to the triassic cephalopoda of Chitichun the appearance of a fauna of the lower Muschelkalk. The triassic limestones of Chitichun may therefore be considered as forming a lower division of the Indian Muschelkalk, corresponding possibly to the horizon of *Sibirites Prahlada* in the main region of the Himálayas. With this view the occurrence of *Xenodiscus* agrees best. The persistence of the geologically older type of *Xenodiscus* in the triassic beds of Chitichun is counterbalanced by the isolated occurrence of *Procladiscites Yasoda*, which is very closely allied to a species of the upper Alpine Muschelkalk.

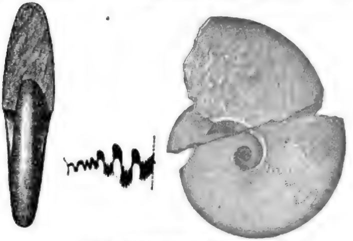
The considerable predominance of the *Ammonea leiostraca* in this fauna is rather remarkable. Each of the three species of *Trachyostraca* is only represented by one single specimen in my collection. Among the *Leiostraca*, *Monophyllites* prevails, which is missing in the Muschelkalk of the main region of the Himálayas. But in the triassic limestones of Chitichun not a single species of *Ptychites* or of *Meekoceras* has been met with, whereas these two genera afford, besides the *Ceratites*, the most important leading forms of the Muschelkalk in the main region; the latter are only represented in the fauna of Chitichun by the sub-genus *Danubites*.

This sharp palæontological separation of the two faunas is to be explained principally, as I believe, by a difference of facies. The Muschelkalk of the main region of the Himálayas is a normal sediment, spread equally over a large area, whereas the triassic limestones of Chitichun and the geologically younger rocks to the east of the Balchdhura Pass of upper-triassic age, characterised by the occurrence of the genus *Jovites* E. v. Mojs., seem to be a local development and to represent the Hallstatt-facies in the Indian triassic province.

The relations between the triassic fauna of Chitichun and the Mediterranean Muschelkalk are clearly indicated by *Procladiscites Yasoda* and in some of the species of the genus *Monophyllites* allied to *M. Suessi* v. Mojs. or to *M. sphaerophyllus* v. Hauer. On the other hand the occurrence of the genus *Sibirites* and of *Danubites Kansa*, closely allied t the Japanese *D. Naumanni* v. Mojs. points to a close relation with the Arctic-Pacific Province of the Trias.

APPENDIX TO PART II.

To the representatives of the subgenus *Aspidites* in the Himálayan trias a species from the triassic limestone crags of Chitichun must be added, the description of which has not been given in the second part of this volume. To this species I attribute the name:



ASPIDITES KOSSMATI nov. sp.

TRIASSIC LIMESTONE OF CHITICHUN.

a. Side view, *b*. Front view, *c*. Sutural line.

The specimen, on which this species is founded, was accidentally discovered by Dr. Kossmat, Assistant at the Geological Museum of the University of Vienna, amongst the collections from Chitichun. I had at first mistaken it for *Procladiscites Yasoda*, but as it seemed rather insignificant, being only an internal cast, did not consider it good enough to develope its sutures and umbilical region. It was only after carefully preparing the latter that its true generic position was revealed.

Among the Salt Range species of *Aspidites* there is none more closely allied to ours than *Aspidites magnumbilicatus*, Waagen (Fossils from the Ceratite Formation, Pl. XXVI, fig. 5 a, b, c, p. 221).

In general shape it is rather similar to this species and the umbilicus is but little smaller in the Chitichun form. The involution is nearly identical, the overlap of the last volution over the penultimate whorl occupying less than two thirds of the entire height of the latter and exactly two sevenths of the height of the last volution.

The transverse section of our species differs from *A. magnumbilicatus* especially by its sides being flatter and converging from the umbilical margin towards the siphonal area in an almost even, scarcely convex slope. The largest transverse diameter corresponds to the umbilical margin, which in more advanced stages of growth becomes slightly elevated and divided from the adjoining sides by a very shallow circular depression.

The siphonal area is regularly rounded and unites gradually with the sides without forming subangular edges. Such are, however, distinctly marked in the juvenile stage and correspond to a diameter of 20 mm. The umbilical margin is perfectly sharp and surrounded by a comparatively high, perpendicular umbilical wall, but the latter does not overhang, as in *A. magnumbilicatus*.

As the specimen under description is only internal cast, the shell surface is unknown. The

cast is nearly smooth, with indistinct traces of falciform ribs. The shell seems to have been covered with faint falciform folds, similar to the sculpture exhibited on the shell of *A. magnumbilicatus* the internal cast of which is described by Waagen as being entirely smooth.

The present specimen, attaining a diameter of 74 mm. is composed of air chambers only, no part of the body chamber having been preserved.

Sutures.—This species is a typical representative of the subgenus *Aspidites*, by reason of the arrangement of the auxiliary series in its sutural line. It belongs to Waagen's section of the *polymeri* the denticulations of the first auxiliary lobe being of unequal size and not symmetrically arranged.

The sutural line, which is very well preserved, differs from that of *A. magnumbilicatus* only in minor details, especially in the arrangement of the auxiliary elements, following the first auxiliary lobe. The siphonal lobe is remarkably broad, provided with irregular indentations and divided by a broad pyramid shaped median prominence. The two lateral lobes are considerably narrower, and provided with strong denticulations at their base, but of unequal number in the different septa. Both in the siphonal and lateral saddles the highest point is shifted towards the umbilical side. The saddles are more slender and narrow than in *A. magnumbilicatus*, the siphonal saddle is bordered by parallel margins, not phylloid in its outlines. The principal lateral saddle is but slightly longer than the second lateral and siphonal saddles. The first auxiliary lobe is less broad than the adjoining lateral saddle, and bears four denticulations below. Among them those nearer to the umbilical side of the lobe are the larger ones, imparting to the lobe a somewhat sloping character. The next auxiliary lobes and saddles likewise slope towards the umbilical suture. The first and second auxiliary saddles are perfectly conical in shape and are separated by a sharply pointed lobe. The third auxiliary lobe is equally pointed but the adjoining saddle is obliquely rounded above, and even provided, as it seems, with a few slight indentations. It is divided by the umbilical edge. The fourth auxiliary lobe is situated on the umbilical wall, and exhibits in opposition to the preceding lobes a strongly bifid termination. It is followed by another small rounded saddle, which reaches down to the umbilical suture.

As the specimen is cut into two by a fissure which has caused a displacement of the portions on both sides, I cannot give the measurements of the entire specimen, but only such as correspond to a diameter of the shell of 58 mm.

These measurements are as follows :—

Diameter of the shell		58 mm.
" " " umbilicus		10
Height of the last volution	from the umbilical suture	28
	" preceding whorl	20
Height of the umbilical wall		4·5
Thickness of the last volution		app. 17

Locality.—Triassic limestone crags of Chitichun in Tibet.

Remarks.—The presence of a representative of the subgenus *Aspidites* in the fauna of the triassic limestone crags of Chitichun is of special interest. In the description of this fauna, contained in the last chapter of the second part of this volume I observed that the majority of its elements are muschelkalk types, but that they are associated with forms bearing a more antique character than the general geological character of the fauna, I therefore drew the conclusion that the triassic limestone of Chitichun may be considered to form a lower division of the Indian muschelkalk. This view is confirmed by the presence of *Aspidites* which is a geologically older type than the *Meekoceratidæ* of the muschelkalk. Up to now species of *Aspidites* have only been found in the upper division of the lower trias of the Indian region. The Salt Range species of this subgenus are all confined to the Ceratite sandstone, where they make their first appearance in its middle division, the Stachella beds. The occurrence of *Aspidites* and of *Xenaspis* consequently confers a rather antique aspect to the fauna of the triassic Chitichun limestones, whereas the occurrence of *Procladiscites Yasoda* has the contrary effect.

From all this it appears to me in accordance with my former views on this subject that the rocks containing the triassic fauna of Chitichun must be placed rather low in the Muschelkalk series. It cannot, however, be decided whether they are on a level with the horizon of *Sibirites prahlada* in the main region of the Himálayas, or with the upper Ceratite limestone of the Salt Range.

LIST OF ERRATA IN PAL. IND. SERIES XV, VOL. II, PART 2.

Page 27 line 16 from top, *for* ours *read* our.
,, 27 ,, 17 ,, ,, ,, referenee *read* reference.
,, 27 ,, 3 ,, bottom ,, obe ,, lobe.
,, 28 ,, 1 ,, top, ,, et ,, ex.
,, 37 ,, 18 ,, ,, ,, Shalshal *read* Shalshall cliff.
,, 59 foot-note ,, Akademied ,, Akademie d.
,, 60 line 21 from top ,, Pinnacoceras ,, Pinacoceras.
,, 63 last line ,, Malletiani ,, Malletianus.
,, 65 in the table XII, the number of radial ribs should be 25 and not 5.
,, 67 foot-note *for* Reichsaustalt *read* Reichsanstalt.
,, 70 line 13 from above ,, ,, ,, ,,
,, 71 foot-note ,, ,, ,, ,,
,, 72 ,, ,, ,, ,, ,,
,, 76 below II, in the table of dimensions *for* (Pl. XX, fig. 2), *read* (Pl. XX, fig. 1).
,, 76 foot-note [1] should be [3] and refers to the above II.
,, 76 ,, [2] ,, [1]
,, 76 ,, [3] ,, [2]
,, 88 ,, *for* 4 *read* 48.
,, 94 ,, ,, nordlichen *read* nördlichen.
,, 101 heading, ,, Part III ,, Chapter II.
,, 101 line 14 from bottom, *for* Gemellaro *read* Gemmellaro.
,, 118 ,, 2 ,, ,, ,, t *read* to.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1*a*, *b*, *c*. Ceratites Thuillieri, Oppel; Muth (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

Fig. 2. Ceratites Thuillieri, Oppel var.; Shalshal Cliff near Rimkin Paiar E. G.; Coll. Diener.

Fig. 3*a*, *b*. Ceratites nov. sp. ind. ex. aff. C. Wetsoni, Diener, fragment of outer whorl; Shalshal Cliff near Rimkin Paiar E. G.; Coll. Diener.

Fig. 4*a*, *b*. Ceratites Himalayanus, Blanford; Spiti (locality unknown); Coll. Asiat. Soc. of Bengal. Blanford's type-specimen.

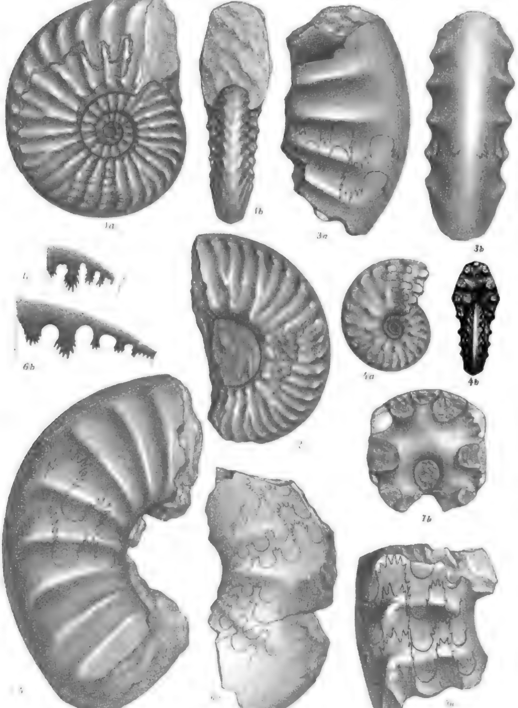
Fig. 5. Ceratites onustus, Oppel, fragment of outer whorl; Kuling (Spiti); Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

Fig. 6*a*, *b*. Ceratites Wetsoni, Oppel, fragment of outer whorl; Spiti; Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

Fig. 7*a* *b*. Ceratites truncus, Oppel, fragment of outer whorl; Kuling (Spiti); Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

Geol. Surv. of India.

MUSCHELKALK, HIMALAYA (CEPHALOPODA) Pl. I.



A. Swoboda del et lith.

Th. Bannwarth print.

PLATE II.

Fig. 1*a*, *b*. Ceratites Voiti, Oppel; Kuling (Spiti), Coll. Stoliczka, Geological Survey Museum in Calcutta.

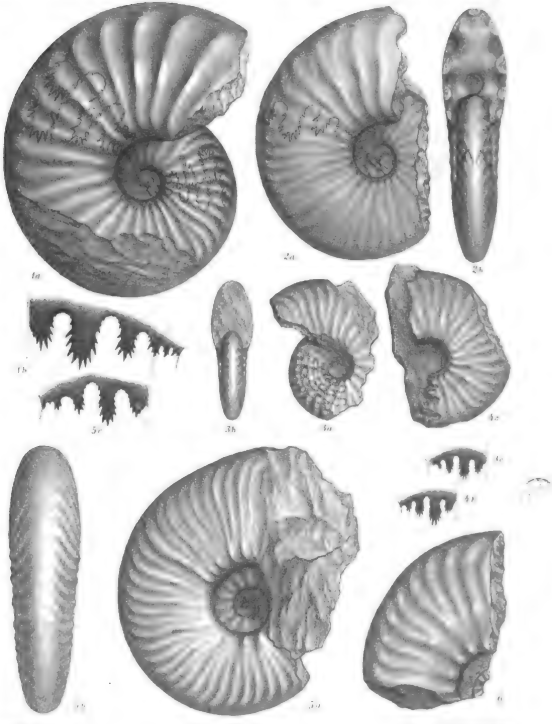
Fig. 2*a*, *b*. Ceratites Voiti, Oppel; a portion of the ventral side restored, after the specimen figured as 1a; Kunzum Pass (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich; Oppel's type-specimen.

Fig. 3*a*, *b*. Ceratites Ravana, Diener, var; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 4*a*, *b*. Ceratites nov. sp. ind. ex. aff. C. Ravana, Diener; fragment of outer whorl; Utadhura (Johar), Coll. Diener.

Fig. 5*a*, *b*. *c*. Ceratites Ravana, Diener; Shalshal Cliff near Rimkin Paiar E. G.; Coll. Diener.

Fig. 6. Ceratites nov. sp. ind. ex. aff. C. Ravana, Diener; Spiti, Coll. Schlagintweit, Palæontological Museum in Munich.



A Swoboda del et lith
Th Bannwarth print

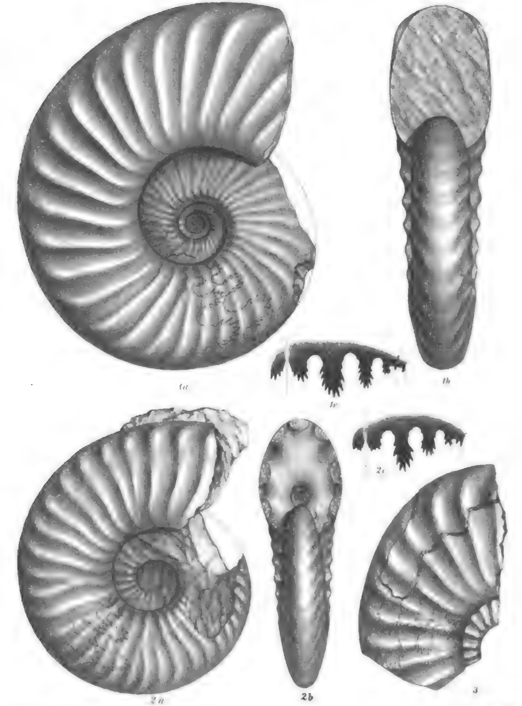
PLATE III.

Fig 1*a*, *b*, *c*. Ceratites Hidimba, Diener; full-grown specimen, with a portion of the shell preserved. East slope of Tsang Tsok La, Hop Gadh (Hundés), Coll. Griesbach, Geological Survey Museum in Calcutta.

Fig. 2*a*, *b*, *c*. Ceratites Dungara, Diener; Kuling (Spiti), Coll. Geological Survey Museum in Calcutta.

Fig. 3. Ceratites sp. ind. ex. aff. C. Hidimba, Diener; probably from Spiti, Coll. Geological Survey Museum in Calcutta.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del et lith.

Th. Bannwarth print.

PLATE IV.

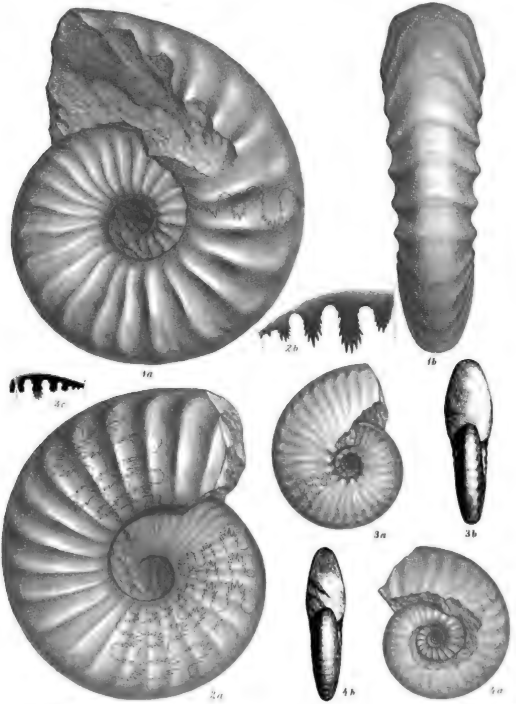
Fig. 1*a*, *b*. Ceratites Arjuna, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

Fig. 2*a*, *b*. Ceratites Visvakarma, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

Fig. 3*a*, *b*, *c*. Ceratites Airavâta, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

Fig. 4*a*, *b*. Ceratites nov. sp. ind., Diener (group of Ceratites circumplicati); Shalshal Cliff near Rimkim Paiar, Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.   Th. Bannwarth print.

PLATE V.

Fig. 1a, b, c, d. Ceratites Kamadeva, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2a, b, c. Ceratites Kuvera, Diener; N. of Kalapani, Kali River Valley (Byans), Coll. Griesbach, Geol. Survey Museum in Calcutta.

Fig. 3a, b. Ceratites sp. ind. from the group of Ceratites Geminati, Mojs.; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

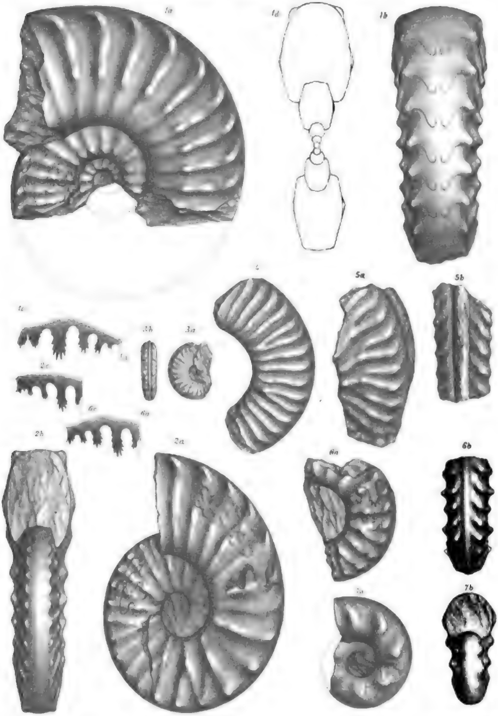
Fig. 4. Ceratites sp. ind.; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 5a, b. Ceratites sp. ind. (group of Ceratites Geminati Mojs. (?); Bambanag Cliffs, Girthi Valley (Johár), Coll. Diener.

Fig. 6a, b Ceratites nov. sp. ind. from the group of Ceratites subrobusti, Mojs.; fragment of outer whorl; Topidunga Valley (Johár), Coll. Diener.

Fig. 7a, b. Ceratites sp. ind. ex. aff. C. Middendorfi, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del et lith.

Th. Bannwarth print.

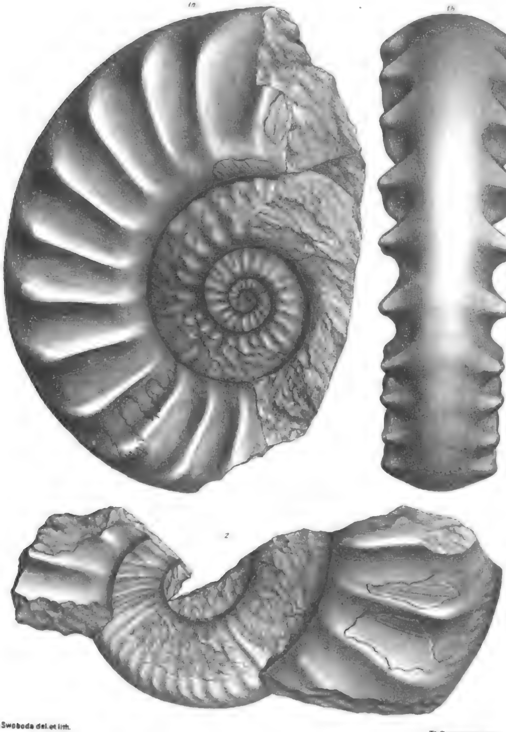
PLATE VI.

Fig. 1*a*, *b* Ceratites Vyasa, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2 Ceratites Vyasa, Diener, cast, with shell partly preserved. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)

Pl. VI



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE VII.

Fig. 1*a*, *b*, *c*. Japonites Sugriva, Diener. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2*a*, *b*. Japonites (?) runcinatus, Oppel, fragment of outer whorl; Shangra (Hundes), Coll. Schlagintweit, Palæontological Museum in Munich; Oppel's type-specimen.

Fig. 3*a*, *b*, *c*. Acrochordiceras Balarama, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

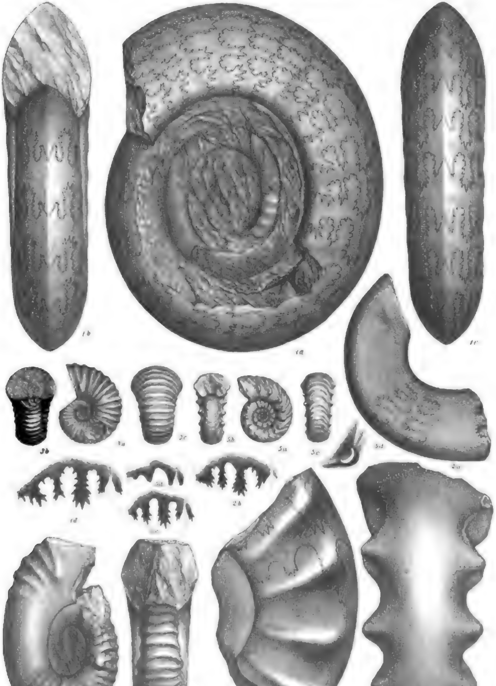
Fig. 4*a*, *b*, *c*. Acrochordiceras Joharense, Diener; Utadhura (Johár), Coll. Diener.

Fig. 5*a*, *b*, *c*, *d*. Sibirites Prahlada, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

Fig. 5 *e*. Tubercle with ribs and lunula of the same specimen, doubly enlarged.

Fig. 6*a*, *b*. Ceratites sp. ind. ex. aff. C. Vyasa, Diener, fragment of outer-whorl; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print

PLATE VIII.

Fig. 1*a, b, c*. Danubites Dritaráshtra, Diener; Utadhura (Johár), Coll. Diener.

Fig. 2*a, b, c, d*. Meekoceras proximum, Oppel; Shangra (Hundés), Coll. Schlagintweit, Palæontological Museum in Munich; Oppel's type-specimen. Fig. *a* and *b* show the view of the specimen from left and right side.

Fig. 3*a, b, c*. Meekoceras Khanikofi, Oppel; Shangra (Hundés), Coll. Schlagintweit, Palæontological Museum in Munich.

Fig. 4, 5*a, b, c, d*. Meekoceras affine, E. v. Mojs.; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 6*a, b, c, d*. Meekoceras Kesava, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 7*a, b, c*. Meekoceras Narada, Diener; Bambanag Cliffs, Girthi Valley (Johár), Coll. Diener.

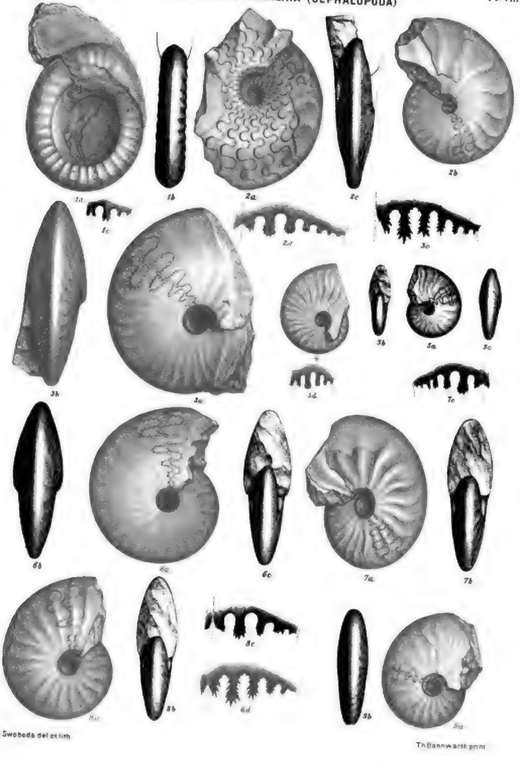
Fig 8*a, b, c*. Meekoceras Srikanta, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 9*a, b*. Meekoceras Srikanta, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Geol. Surv. of India

MUSCHELKALK, HIMALAYA (CEPHALOPODA)

Pl. VIII



A. Swoboda del et lith.

Th. Bannwarth print

PLATE IX.

Fig. 1*a*, *b*. Meekoceras Khanikofi, Oppel, full-grown specimen, with shell preserved. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2. Meekoceras Khanikofi, Oppel, variety, with tubercles; Kuling (Spiti), Coll. Schlagintweit, Palæontol. Museum in Munich.

Fig. 3*a*, *b*. Meekoceras Khanikofi, Oppel; S. E. of Muth (Spiti), Coll. Griesbach, Geological Survey Museum in Calcutta.

Fig. 4*a*, *b*, *c*. Meekoceras Gangadhara, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

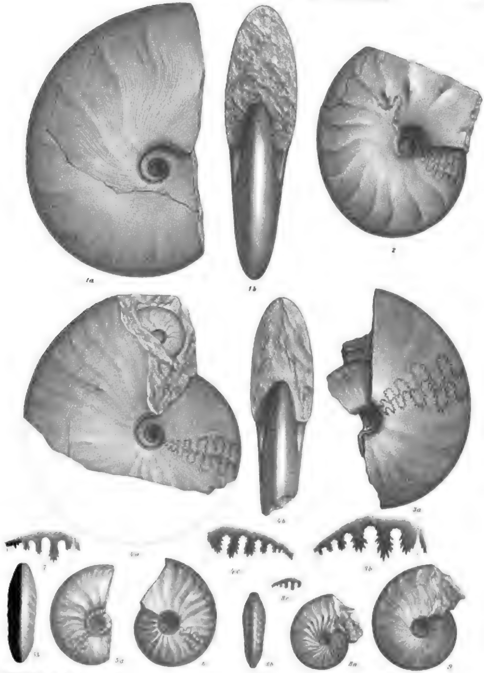
Fig. 5*a*, *b*, *c*. Meekoceras Nalikanta, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 7. Meekoceras Nalikanta, Diener, sutures of a full-grown specimen; Shalshal Cliff, Coll. Diener.

Fig. 8 *a*, *b*, *c*. Meekoceras Nanda, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 9. Meekoceras Khanikofi, adolescent stage; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE X.

Fig. 1*a*, *b*. Meekoceras Rudra, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2*a*, *b*, *c*. Gymnites Kirata, Diener; Lilang (Spiti), Coll. Stoliczka, Geological Survey Museum in Calcutta.

Fig. 3*a*, *b*. Gymnites Kirata, Diener, adolescent form; Lilang (Spiti), Geological Survey Museum in Calcutta.

Fig. 4*a*, *b*, *c*. Japonites Chandra, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

Fig. 5*a*, *b*. Gymnites nov. sp. ind. ex. aff. G. Sankara, Diener; Utadhura (Johár), Coll. Diener.

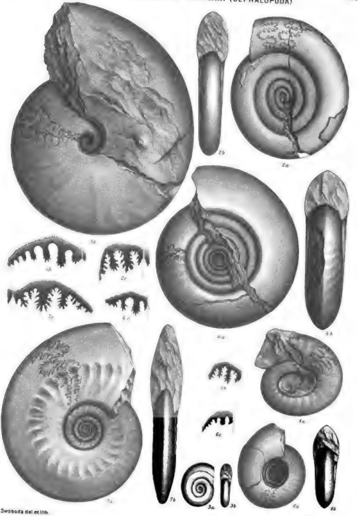
Fig. 6*a*, *b*, *c*. Gymnites Lamarki, Oppel; Kuling (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

Fig. 7*a*, *b*, *c*. Gymnites Jollyanus, Oppel; Muth (Spiti), Geological Survey Museum in Calcutta.

Geol. Surv. of India

MUSCHELKALK, HIMALAYA (CEPHALOPODA)

Pl. X.



A. Swoboda del et lith.

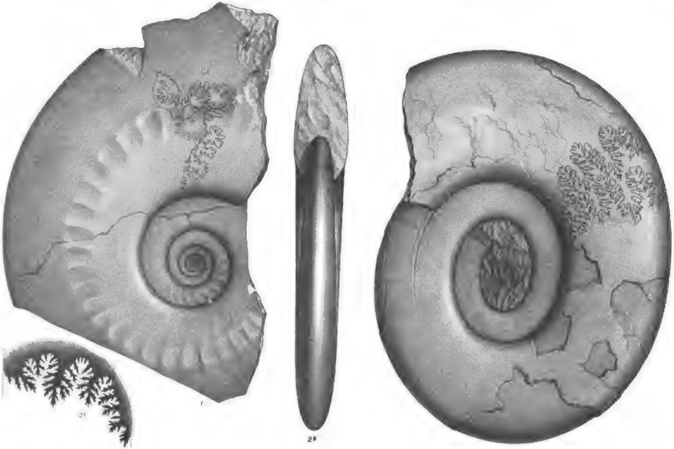
Th. Bannwarth print.

PLATE XI.

Fig. 1*a*, *b*. Gymnites Jollyanus, Oppel; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2*a*, *b*, *c*. Gymnites Sankara, Diener; Lilang (Spiti), Coll. Stoliczka, Geological Survey Museum in Calcutta.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print.

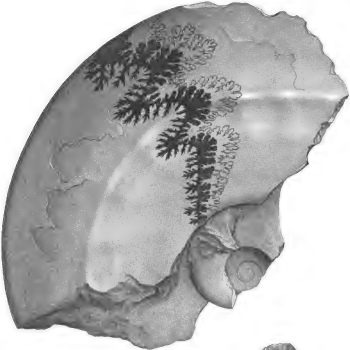
PLATE XII.

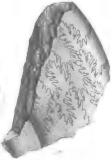
Fig. 1. Gymnites Jollyanus, Oppel, sutures of a full-grown specimen; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2*a*, *b*. Gymnites sp. ind. ex. aff. G. Humboldti, Diener; fragment of outer whorl. Bambanag Cliffs, Girthi Valley (Johár), Coll. Diener.

Fig. 3*a*, *b*, *c*. Gymnites Salteri, Beyrich; Ladakh, Coll. Prochnow, Museum für Naturkunde, Berlin. Copy of a plaster cast after Beyrich's type-specimen.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)





A. Swoboda del. et lith.

Th. Bannwarth print.

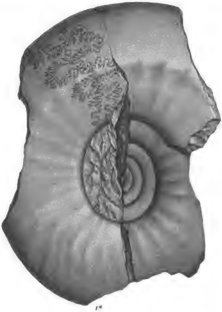
PLATE XIII.

Fig. 1*a*, *b*, *c*. Gymnites nov. sp. ex. aff. G. Sankara, Diener; Kuling (Spiti), Coll. Geological Survey Museum in Calcutta.

Fig. 2*a*, *b*, *c*. Gymnites Vasantasena, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 3. Gymnites (Buddhaites) Rama, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Griesbach, Geological Survey Museum in Calcutta. Sutures of a middle-sized specimen.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)


1a


1b


1c


2a


2b


2c


3

A. Swoboda del. et lith.

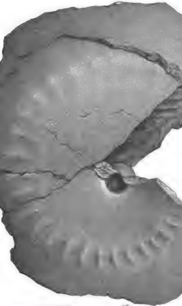
Th. Bannwarth print.

PLATE XIV.

Fig. 1*a*, *b*. Gymnites (Buddhaites) Rama, Diener; west slope of the Silakank Pass, Coll. Griesbach, Geological Survey Museum in Calcutta. In the sutural-line the outer branch of the siphonal saddle and the siphonal lobe are missing.

Fig. 2*a*, *b*, *c*, *d*, *e*. Gymnites (Buddhaites) Rama, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener; *d* and *e* inner whorls of the same specimen.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)

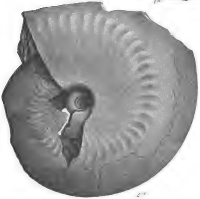


1a

2d

2e

1b



2a

2b

2c

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XV.

Fig. 1a, b. Sturia Sansovinii, E. v. Mojsisovics; Shalshal Cliff near Rimkin Paiar, Coll Diener. Large specimen with shell preserved.

A. Swoboda del et lith.

PLATE XVI.

Fig. 1*a*, *b*, *c*. Ptychites Mahendra, Diener; Muth (Spiti), Coll. Geological Survey Museum in Calcutta.

Fig. 2*a*, *b*. Ptychites Mahendra, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.
2*b*. front-view of the inner whorls of the same specimen.

Fig. 3*a*, *b*, *c*. Ptychites Drona, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)

1b

3b

1c

2b

3a

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XVII.

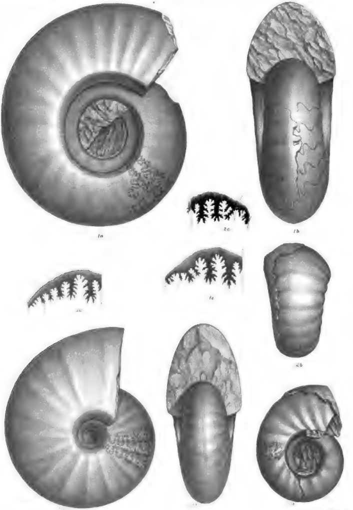
Fig. 1*a*, *b*, *c*. Ptychites Malletianus, Stol.; Lilang (Spiti) Coll. Geol. Survey Museum in Calcutta. Stoliczka's type-specimen.

Fig. 2*a*, *b*, *c*. Ptychites nov. sp. ex. aff. Malletianus, Diener; north of Padam, Spiti, Coll. Geol. Survey Museum in Calcutta.

Fig. 3*a*, *b*, *c*. Ptychites cochleatus, Oppel; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Geol. Surv. of India. Pl. XVII.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XVIII.

Fig. 1. Ptychites Gerardi, Blanford; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener. Specimen with shell partly preserved.

Fig. 2*a*, *b*, *c*. Ptychites Gerardi, Blanf.; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 3. Ptychites Gerardi, Blanf.; Spiti Valley, Coll. Geol. Survey Museum in Calcutta (from the Asiatic Society of Bengal). Blanford's type-specimen.

Fig. 4*a*, *b*. Ptychites impletus, Oppel; Kuling (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

Fig. 5. Ptychites cognatus, Oppel; Kuling (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich.

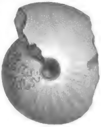
Fig. 6*a*, *b*. Ptychites cognatus, Oppel; Kuling (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich.

Geol. Surv. of India PL. XVIII

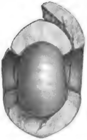
MUSCHELKALK, HIMALAYA (CEPHALOPODA)


1

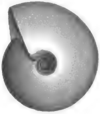

2b


2a


2c


4b

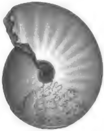

4a


3


4c


5


6b


6a

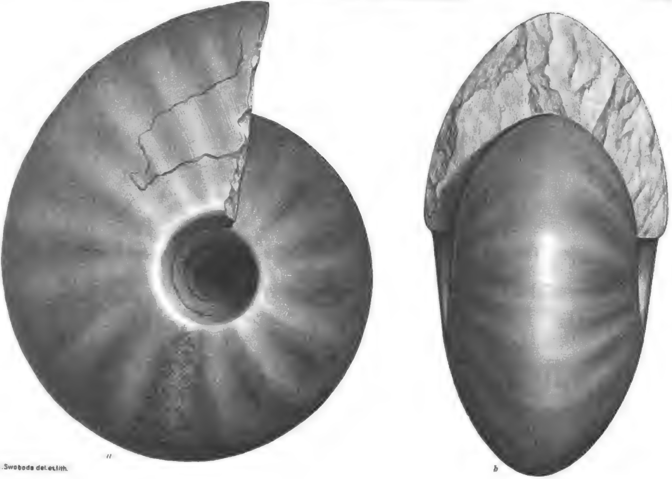
A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XIX.

Ptychites Everesti, Oppel; full-grown specimen; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print

PLATE XX.

Fig. 1*a*, *b*. Ptychites Everesti, Oppel; Shangra (Tibet). Oppel's type-specimen.

Fig. 2*a*, *b*. Ptychites Vidura, Diener; Hundés.

Fig. 3*a*, *b*. Ptychites Vidura, Diener; Spiti.

Fig. 4*a*, *b*, *c*. Ptychites Everesti, Oppel; Spiti.

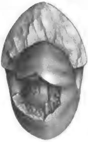
Fig. 5*a*, *b*. Ptychites Vidura, Diener; Hundés.

Fig. 6. Ptychites Vidura, Diener; sutural line, Hundés.

All specimens, figured on this plate, from the Schlagintweit-collection, Palæontological Museum in Munich.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)


1a


1b

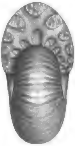

2a


2b

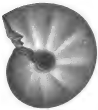

2c


6


3a


3b


4b


4a


5a


5b

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXI.

Ptychites Govinda, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

PLATE XXII.

Fig. 1*a*, *b*. Ptychites rugifer, Oppel ; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 2*a*, *b*, *c*. Ptychites rugifer, Oppel ; Kuling (Spiti), Coll. Schlagintweit, Palæontological Museum in Munich. Oppel's type-specimen.

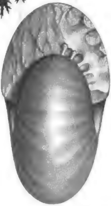
MUSCHELKALK, HIMALAYA (CEPHALOPODA)

1a

1b

2c

2a



2b

Th. Bannwarth print.

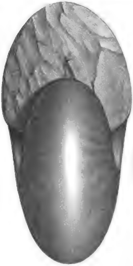
A. Swoboda del et lith.

PLATE XXIII.

Fig. 1a, b. Ptychites rugifer, Oppel; S. E. of Muth (Spiti), Coll. Griesbach, Geolog. Survey Museum in Calcutta.

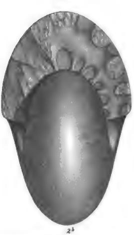
Fig. 2a, b. Ptychites rugifer, Oppel; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



1b

1a



2b

2a

A Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXIV.

Fig. 1*a*, *b*. Ptychites rugifer, Oppel; Spiti, Coll. Schlagintweit, Palæontological Museum in Munich.

Fig. 2*a*, *b*, *c*. Ptychites rugifer, Oppel; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

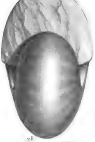
Fig. 3*a*, *b*, *c*. Ptychites tibetanus, Mojs.; Spiti, Coll. Schlagintweit, Palæontological Museum in Munich. E. v. Mojsisovics' type-specimen.

Geol. Surv. of India. Pl. XXIV.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)


1a

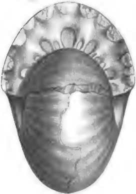

1b


2b


2c


2a


3c


3


3a

A. Swoboda del. et lith.
Th. Bannwarth print.

PLATE XXV.

Fig. 1*a*, *b*, *c*. Ptychites Sahadeva, Diener; N. of Kalapani E. G., Kali River Valley (Byans), Coll. Griesbach, Geological Survey Museum in Calcutta.

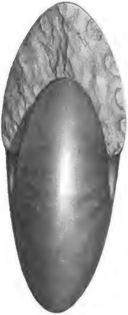
Fig. 2*a*, *b*. Ptychites Sahadeva, Diener, adolescent stage. Same locality.

Fig. 3*a*, *b*. Ptychites Gerardi, Blanford, adolescent stage. Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

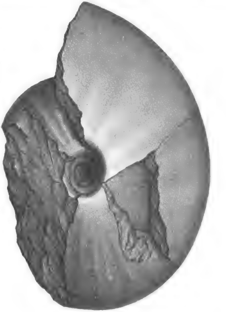
Geol. Surv. of India.

MUSCHELKALK. HIMALAYA (CEPHALOPODA)

Pl. XXV



1b

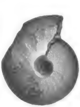


1a

1c

2b

2a



3a

3b

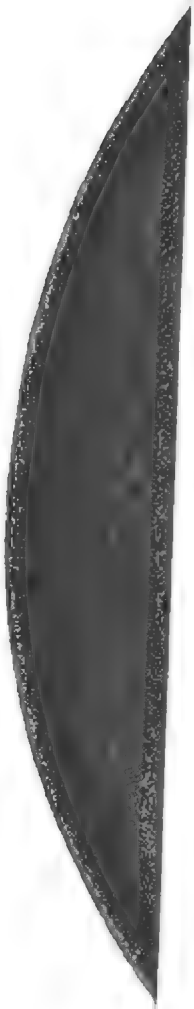
A Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXVI.

Ptychites Sumitra, Diener; Shalshal Cliff near Rimkin Paiar, Coll. Diener.

Geol. Surv. of India



A. Swoboda del. et lith.

PLATE XXVII.

Fig. 1*a*, *b*, *c*. Ptychites Mangala, Diener; Spiti, Coll. Schlagintweit, Palæontological Museum in Munich.

Fig. 2*a*, *b*. Ptychites Sukra, Diener; Spiti, Coll. Schlagintweit, Palæontological Museum in Munich.

Fig. 3*a*, *b*. Isculites Hauerinus, Stoliczka; Lilang (Spiti), Coll. Geological Survey Museum, Calcutta (Stoliczka's type-specimen).

Fig. 3*c*. Isculites Hauerinus, Stoliczka; copy of the sutures of another specimen, after Stoliczka (compare Pl. XXXI., Fig. 11b).

Fig. 4*a*, *b*, *c*. Lobites Oldhamianus, Stoliczka; Lilang (Spiti), Geological Survey Museum, Calcutta (Stoliczka's type-specimen).

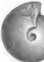
Fig 5*a*, *b*, *c*. Ptychites Asura, Diener; Lilang (Spiti), Geological Survey Museum, Calcutta.

Fig. 6. Proarcestes Balfouri, Oppel; Dras (Tibet), Coll. Schlagintweit, Palæontological Museum in Munich (Oppel's type-specimen).

Fig. 7*a*, *b*, *c*. Proarcestes Balfouri, Oppel; East slope of Tsang-Tsok-La (Tibet), Geological Survey Museum, Calcutta, Coll. Griesbach.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)


1b


3a

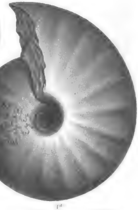

3b


1c


1d

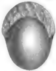

5c

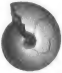

4c

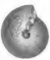

1a


2b


2a

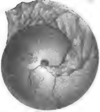

5b

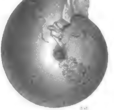

5a

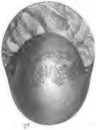

4a


4b


7c


6


7a


7b

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXVIII.

Fig. 1*a*, *b*, *c*. Proarcestes bicinctus, E. v. Mojsisovics; Lilang (Spiti), Geological Survey Museum, Calcutta; Coll. Stoliczka.

Fig. 2*a*, *b*. Nov. genus ind. ex. fam. Arcestidarum sp. ind.; Shalshal Cliff near Rimkin Paiar E. G., Coll. Diener.

Fig. 3. Nov. genus ind. ex fam. Arcestidarum sp. ind.; Sutures of a specimen from the same locality, Coll. Diener.

Fig. 4. Nautilus sp. ind. ex. aff. N. Griesbachi, Diener; Shalshal Cliff near Rimkin Paiar E. G., Coll Diener.

Fig. 5. Nautilus Spitiensis, Stoliczka; Lilang (Spiti), Geological Survey Museum, Calcutta (Stoliczka's type-specimen).

Fig. 6*a*, *b*. Nautilus Griesbachi, Diener; N. of Kalapani, Kali River Valley (Byans), Coll. Griesbach, Geological Survey Museum, Calcutta.

Fig. 7. Nautilus Griesbachi, Diener; a large specimen from the same locality, Coll. Griesbach.

Fig. 8*a*, *b*. Orthoceras cf. campanile, v. Mojsisovics; Utadhura Pass (Johár), Coll. Diener.

Fig. 9*a*, *b*. Atractites sp. ind.; Spiti, Coll. Geological Survey Museum, Calcutta.

Fig. 10*a*, *b*. Orthoceras sp. ind. ex. aff. O. campanile; Spiti, Geological Survey Museum, Calcutta.

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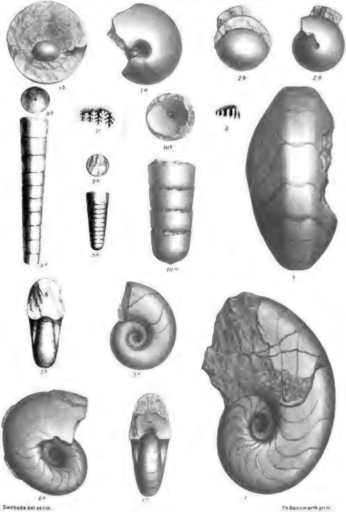
Pl. XXVIII.



A. Swoboda del. et lith.
Th. Bannwarth print.

PLATE XXIX.

Fig. 1*a*, *b*, *c*. Danubites Kansa, Diener.

Fig. 2*a*, *b*, *c*. Danubites Ambika, Diener.

Fig. 3*a*, *b*, *c*. Sibirites Pandya, Diener; 3*c*. Sutures incorrectly drawn, two lateral lobes only and no auxiliary lobe.

Fig. 4*a*, *b*, *c*. Sturia mongolica, Diener.

Fig. 5*a*, *b*. Orthoceras sp. ind.

All specimens from the triassic limestones of Chitichun (Tibet), Coll. Diener.

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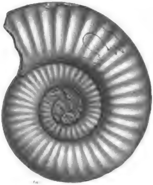
Pl. XXIX.

1b

1c



1a

5b

2b

2a

3b

3a

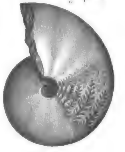
4c

2c

3c

5a

4b



4a

A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXX.

Fig. 1*a*, *b*.
Fig. 2*a*, *b*. } Procladiscites Yasoda, Diener.
Fig. 3*a*, *b*, *c*.

Fig. 4. Xenodiscus, nov. sp. ind.

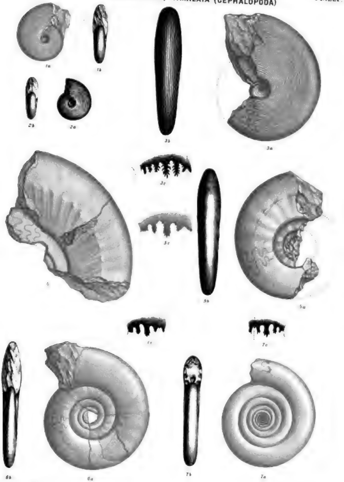
Fig. 5*a*, *b*, *c*. Gymnites Ugra, Diener.

Fig. 6*a*, *b*, *c*. Xenodiscus Middlemissi, Diener.

Fig. 7*a*, *b*, *c*. Monophyllites Confucii, Diener.

All specimens from the triassic limestones of Chitichun (Tibet), Coll. Diener.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XXXI.

Fig. 1*a*, *b*, *c*.
Fig. 2*a*, *b*. } Monophyllites Confucii, Diener.

Fig. 3*a*, *b*, *c*.
Fig. 4*a*, *b*. } Monophyllites Pradyumna, Diener.

Fig. 5*a*, *b*. Monophyllites Pitamaha, Diener; young specimen.

Fig. 6*a*, *b*. Monophyllites, nov. sp. ind.

Fig. 7*a*, *b*, *c*.
Fig. 8*a*, *b*. } Monophyllites Pitamaha, Diener.

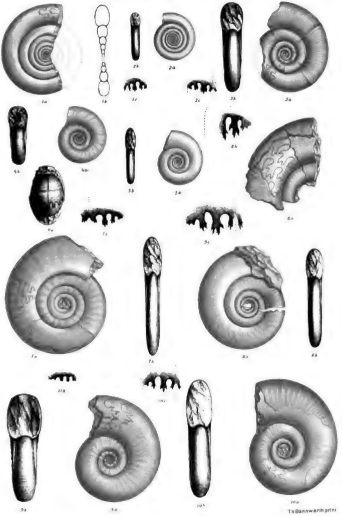
Fig. 9*a*, *b*, *c*. Monophyllites Hara, Diener.

Fig. 10*a*, *b*. *c*. Monophyllites Kingi, Diener.

All specimens from the triassic limestone of Chitichun (Tibet), Coll. Diener.

Fig. 11*a*, *b*. Isculites Hauerinus, Stoliczka; Lilang (Spiti), Geological Survey Museum, Calcutta, Stoliczka's type-specimen. Side-view of the inner volutions and sutures, the last whorl (body-chamber) having been taken off.

MUSCHELKALK, HIMALAYA (CEPHALOPODA)



A Swoboda del et lith.

Th. Bannwarth print.